JANUARY, 1934

METALS & ALLOYS

PRODUCTION — FABRICATION — APPLICATION

INCLUDING

CURRENT METALLURGICAL ABSTRACTS

ENDURO

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AND HEAT-RESISTING STEELS

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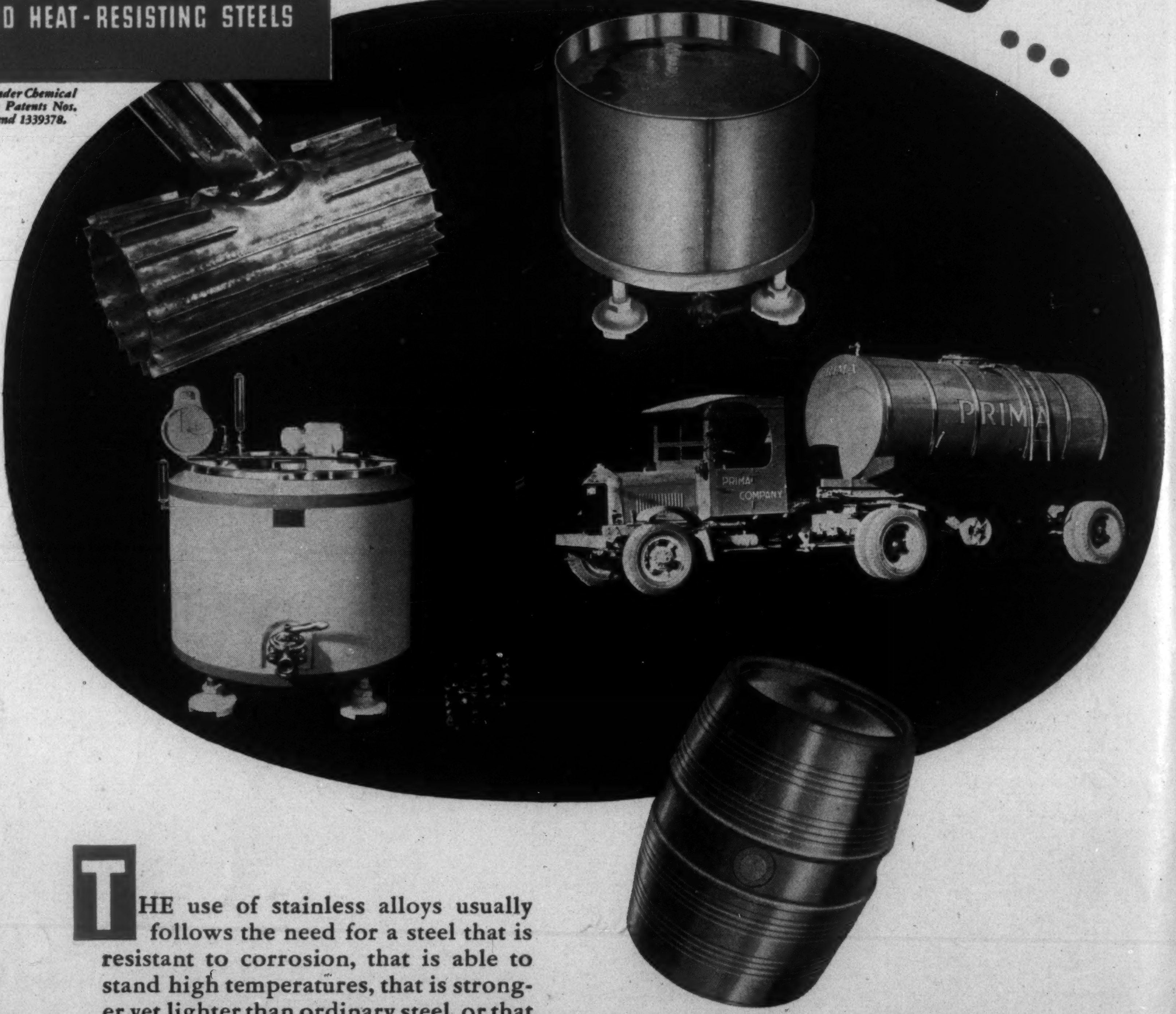

THE use of stainless alloys usually follows the need for a steel that is resistant to corrosion, that is able to stand high temperatures, that is stronger yet lighter than ordinary steel, or that must retain its beauty for decorative purposes. ENDURO, Republic's Perfected Stainless Steel, meets all these requirements, yet the decision to use ENDURO is often based on an entirely different quality—its weldability.

The excellent welding qualities of ENDURO played an important part in the decision to use it in the airplane exhaust manifold, the beer barrel and other items illustrated. Some were gas welded, some electric welded, and results proved that this modern metal is easy to weld by any of the accepted commercial methods in shop use today, except forge or fire welding, provided the correct procedure is followed.

Republic has published Booklet No. 116 giving in detail the recommended practice covering gas, arc, spot, seam and flash welding. A copy will be sent upon request.

CENTRAL ALLOY DIVISION • • MASSILLON, OHIO

REPUBLIC STEEL CORPORATION

GENERAL OFFICES R YOUNGSTOWN, OHIO

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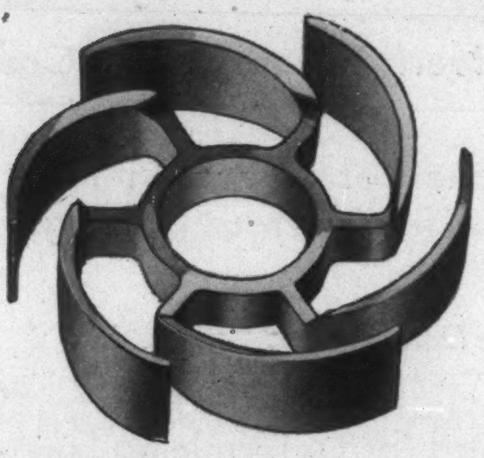
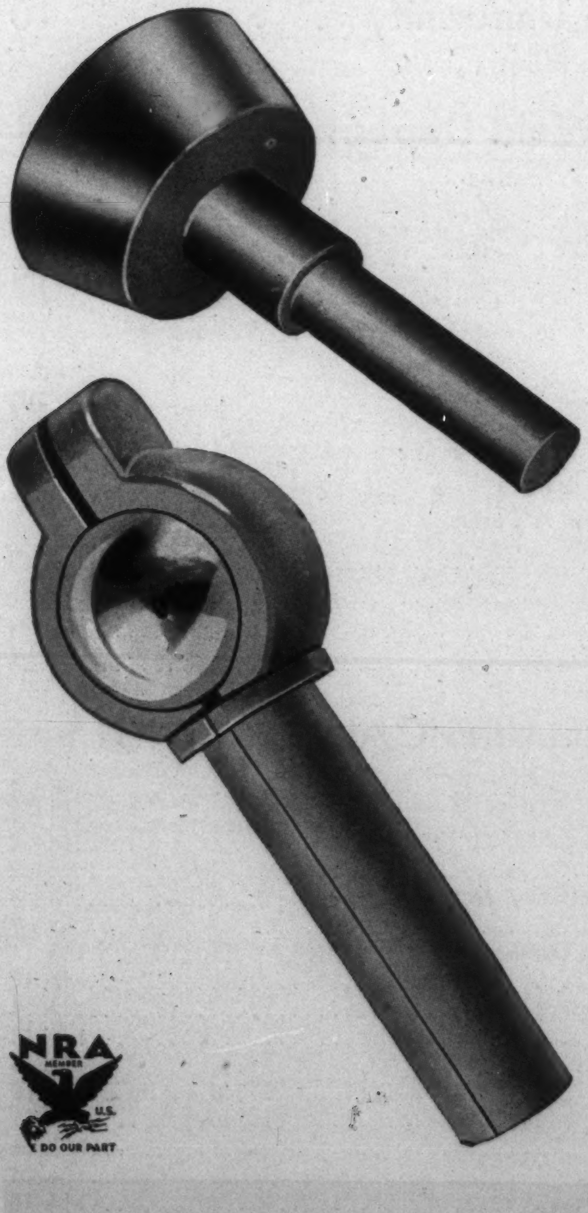
Dependable Uniformity in Aluminum Bronze Parts Opens a Wide Field for Designing Engineers





MECHANICAL DESIGNERS have, for many years, recognized that aluminum bronze, at its best, possesses an extraordinarily valuable combination of qualities—great tensile strength, a hardness suited to present-day products, high resistance to corrosion, and retention of considerable strength at elevated temperatures.

In spite of this array of good qualities, however, the use of aluminum bronze has been seriously retarded by the lack of a technique for handling this alloy in quantity production. Older methods often produced an alloy which failed to display a dependable uniformity under prolonged quantity tests.

In order to overcome this defect and place at the disposal of designing engineers the desirable qualities of aluminum bronze, the Aurora Metal Co. has developed and commercially standardized a vacuum die-casting process which insures in the product uniformity in composition, hardness, and strength.

Stronger-Than-Steel Die Castings have an average tensile strength of 85,000 lb. per square inch, a hardness of 65 Rockwell B, 140 Brinell, as cast, an effective resistance to corrosion, and an ability to retain a large percentage of their strength at high temperatures. They show exceptional resistance to wear, abrasion, and shock. They come from the dies uniform in size and shape and with such a smooth clean finish that little time is required for machining and finishing.

Stronger-Than-Steel Die Castings are not new but their introduction into industry has been conservative. Today, their absolute dependability is indicated by their wide-spread use as vitally important parts of many successful products.

Our latest Bulletin, No. 4, outlines the characteristics of Stronger-Than-Steel Die Castings and presents pertinent information regarding types of parts for which they are particularly adapted.

Aurora Metal Company
Incorporated
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ALUMINUM BRONZE
STRONGER-THAN-STEEL
DIE CASTINGS

HIGHLIGHTS

by H. W. GILLETT

Inclusions in Steels

Different methods for more or less quantitative determination of inclusions in some steels, but not all, are discussed by Fitterer and 5 associates, and by Cunningham & Price (page MA 24 L1 & 3).

Porosity of Copper

Allen and co-workers (page MA 30 L2 to 5) ascribe porosity of Cu and Cu Ni to hydrogen.

Antimony a Deoxidizer in Leaded Bronzes

A quarter of a percent of antimony in leaded bearing bronzes hasn't any harmful effect, and may be a deoxidizer, according to Thews (page MA 30 R1).

Tiny Additions to Zinc

Tiny additions of lots of elements to zinc are studied by Burkhardt & Sachs (page MA 30 R4). Some of them are helpful, but none of them will counteract the harmful effect of Fe on corrosion resistance.

Manganese and Quenching Speed

1% manganese lowers the critical quenching speed of carbon steels 80%, thus favoring depth hardening, according to Jellinghaus (page MA 30 L10).

Sized Charges in Blast Furnace

Sized charges in the blast furnace reduced the necessary blast pressure and cut coke consumption 10%, in work reported by Wagner, Holschuh and Barth (page MA 32 L1).

Flotation of Beryl

Beryl can be separated from quartz by flotation, according to Italian work (page MA 33 L7). Concentration of the ore before chemical treatment, it has previously been pointed out, is a promising road to reduction in cost of metallic Beryllium.

"Revolutionary" Crushing Mill

Crushing 2 ft. lumps to 200 mesh in the new Hadsel mill in one operation at half the cost of older methods (page MA 33 L8) justifies the word "revolutionary" in the title of the article.

DO YOU want to know what metallurgical engineers are saying, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

Wear and Corrosion

Ricardo (page MA 6 R8) says that Diesel engine cylinder wear is not abrasive wear since carburized and nitrided steels are more worn than cast iron. High Cr cast irons act better than plain cast iron, so corrosion is suggested as the cause of wear instead of abrasion. However, other observers such as Dorey (page MA 6 R10) class nitrided steel as corrosion resistant in uses such as water cooled piston rods.

Book Reviews

Reviewers especially like two foreign books, one of 686 pages on Die Castings by Frommer in German (page MA 21 L1), and one by Poretzki in Russian on The Theory of Forging (page MA 22 L9) and wish they could be translated. Incidentally, the review of the die casting book itself gives several facts and references omitted by the author.

Low Alloy Steels

Low alloy steels with cheap alloying elements are getting plenty of notice. Besides "Cromansil," of which we have heard so much, a CuCr steel called "Chromador" and containing about 1% Cr ½% Cu is commented upon in several engineering journals, especially those relating to marine engineering (page MA 2 R3 and R4).

"We do our part"

According to the interesting series "Large Uses of Steel in Small Ways" (page MA 13 R10) 50 tons of steel a year is used in making pipe cleaners. Well, "we do our part" in helping the steel industry in that way, but after all, the aid we give the lumber and chemical industries by way of matches is still more generous. So far we haven't had occasion to be concerned personally with handcuffs, also dealt with in the series (page MA 13 R6).

A 19 Chromium, 8 Tantalum Steel

Kalpers (page MA 2 R10) discusses a steel of the 18-8 type, with 19% chromium and 8% tantalum, said to be especially scale-resistant at high temperature.

Soft Spots in Quenching

To avoid soft spots in quenching, a coating of a powered slaty clay on the quenched piece allows gas to be released instead of the bubbles sticking to the piece and insulating it so as to give slow cooling and a soft spot. This is the interpretation of Sato of an old practice of Japanese cutlery makers (page MA 17 L4).

Sodium Carbonate has Oxidizing Effect in Molten Cast Iron

Reactions written by Girardet and Lelievre (page MA 20 R1) for the action of sodium carbonate with molten cast iron show formation of free sodium and CO and CO_2 by reduction with carbon or Fe_3C, but that the action of Fe on Na_2CO_3 gives not only CO_2 and Na but also FeO. They state that free Na reduces metallic oxides in the bath, so in the end the reaction would go back to produce sodium oxide and iron. But any loss of Na by combination with S or by volatilization would leave FeO in the metal. So, were Na_2CO_3 used on a low carbon steel for desulphurization (and Siegel, page MA 20 R4, so uses it) it should have an oxidizing effect if the reaction given is correct.

Spontaneous Combustion of Zinc

According to Sebborn (page MA 6 R2) finely divided Zn will burn spontaneously in air if it is moistened with caustic soda or potash solution which dissolves off the protective oxide film and permits progressive oxidation.

Combined Carbon in Cast Iron

Le Thomas & Morlet (page MA 8 L6) claim that at moderately high or even relatively low temperatures the combined carbon of ordinary cast iron is not absolutely stable, but may graphitize.

STEEL SPECIFICATIONS IN 1934

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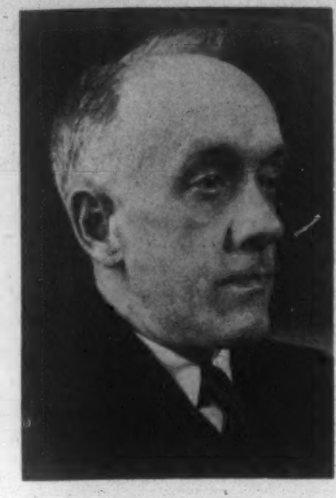


EDITORIAL COMMENT

EXECUTIVE CONTROL OF RESEARCH FOR PROFITS

A Prelude to a Series of Case Histories in Metallurgical Research

EXECUTIVES, rather than research men themselves, are in very many cases, the ones primarily responsible for the success or failure of research projects. Some executives set the stage for research so that a successful performance is practically inevitable, while others set it so that the performance can only be a flop. Certain facts brought out by one research group in one firm may lead exactly nowhere, while the same facts brought out by a no more capable research group, in another firm, may lead to large profits.

It should be possible to analyse the conditions surrounding research and bring out the factors that attend success and failure. Much has been written about the end-products of research, but too little attention has been paid to the process of research itself. Let us do some research on the subject of research.

Probably the best way to attack the problem is to use the "case system." By examination of the material and psychological circumstances surrounding specific research projects that turned out well or ill, we should be able to reach useful conclusions to guide in handling a new project. Examples could be drawn from many fields, but there are plenty in our own field of metallurgy.

We have therefore arranged with some of our Editorial Advisory Board and other metallurgists and metallurgical executives to present in succeeding issues of METALS & ALLOYS, *from their own personal histories, cases of research successes and failures in their own work or that under their supervision or observation, with their own analysis of the reasons for the outcome.*

Men of this caliber, applying hindsight to their earlier failures, have appraised the reasons for them and utilized that information in planning successful research. That's how they built up their batting average. Having themselves profited by research, they are now willing to pass this experience on to others, in very frank fashion. The sub-title of this series might be "Confessions of Research Men."

Before getting down to individual case histories, some general principles that will be illustrated by the series will be discussed. At the start, it is well to define research, to state what one means by "a successful piece of research," and to classify some of the various types of research.

What is research?

The exact definition of research depends on one's point of view, but however defined, it always connotes a search for the unknown, a hunting for an answer to a problem to which the answer is not known in advance—generally with no absolute certainty that there is an answer at all. Thus, it has some of the elements of a gamble. It is exploration and pioneering, allied to discovery and invention.

Routine testing is not research. Too often the double duties of production control and of research and development are laid upon a group called the research staff which is expected to exercise technical control of production for quality and quantity and, as well, to wave a magic wand at odd moments and perform some research miracles. If research is worth doing, it is worth doing wholeheartedly.

Research is not engineering, for engineering is the application of known facts. The engineer makes more of something that has been made before or applies thoroughly established principles, methods, materials, and equipment discovered or invented by others. There should be no gamble in an engineering operation. The answer is known and it is the engineer's task to make his problem show an answer agreeing with the answer that has been established.

Research may then be briefly defined as the precursor of engineering.

"Successful" research

The second definition, that of successful research, is simple. A successful research accomplishes what it sets out to do (or something still more important): It is therefore necessary for the management to realize clearly, when it sets up a research department of its own, sponsors a project at some research institution, or approves a program for or the extension of a specific investigation, just what it wants to come out of the research.

The executive will reply tersely that what he wants is profits. But today's profits result not only from what has been done yesterday, they come also from what was done long before. They depend a lot on the avoidance of mistakes that might have been made. Hence, profitable research may be that which obviously brings profits tomorrow, that which builds profits years hence, or that which merely avoids mistakes and losses. Different types of research are required depending on what the objectives are.

Research for training's sake

If we are to have research in the future, research men must be trained. Hence, we have one type of research, the educational type, which aims solely to instruct a student in research methods. If the work accomplishes this, training him so he may later perform other types, when he stands on his own feet away from the professor's guidance, the end is attained, whether or not in the course of the work he finds new and useful information. Proof of the professor's success lies not in the theses, but in the lives of his students.

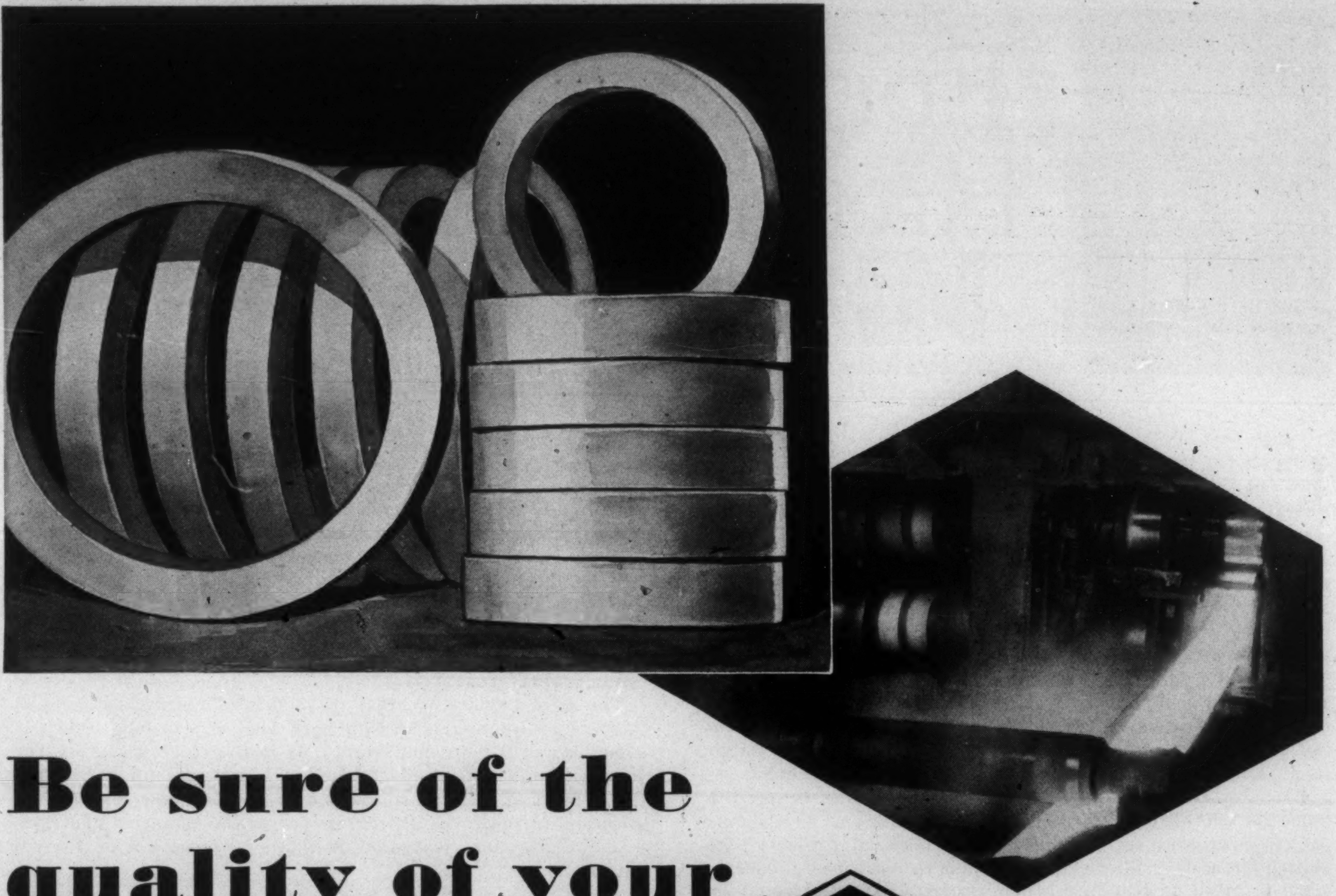
Research for research's sake

The more advanced type of university research, carried on by the professor himself, with such aid as he can get from his students, is performed partly for the mental satisfaction of the worker, partly for what the results may add to science. Such investigations are limited by funds, time and equipment available and are seldom aimed at specific industrial problems. If immediate utility appears, it is a by-product.

This type of research may, it is true, enter untrodden fields and open up future industrial possibilities. More often, it just skirts those fields.

A few large corporations with farflung interests actually enter and plow these fields of pure science, with no definite crop in mind, but merely seeing what they can unearth. If this is carried on long enough and on a large enough scale, something may be hit upon that can be commercialized in time to repay the expense, but on any but a very extensive scale, it

(Continued on page A 19)



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classes as a gamble, pure and simple. Kettering[1] refers to this as the "Monte Carlo" type of research, and Chubb[2] says of the strictly fundamental work carried on with no application in view, "All pioneer research is speculative, and much of it is worthless."

The academic mind does not readily grasp this, and some of the older school are inclined to phrase matters in diametrically opposite terms. Thus, we are told, "The deliberate attempt to create something of immediate utility leads as a rule to shoddy work of only passing value."[3]

Obviously this need not necessarily be true, and it is coming to be less and less of an approach to the truth. Will Rogers' comment over the radio anent the Wickersham Commission is apropos. He remarked that data are like garbage, it's no use collecting them unless you have some place to put them right away.

Oriented vs. butterfly research

Hunting for something that is definitely wanted in order to clarify the understanding of some basic problem is more likely to be effective than just hunting for anything. As long as one is working beyond the boundaries of present knowledge, he is just as likely to stumble onto important new facts not related to his main problem when he has a main problem as when he has no goal in view, and is merely roaming the untrodden fields of pure science.

Oriented research, carried on by the methods of pure science but, having a goal set by the present needs of industry, can be just as worthy of attention, and just as mentally satisfying as butterfly research in pure science. The pose of some self styled "pure scientists" in disdaining work of immediate utility might even raise the question whether men with that mental attitude would actually be capable of doing the careful detail work necessary to find the real answer to a problem. Possibly the grapes are sour. At any rate, the broader the scientist and the bigger the man, the more interested he generally is in working out, for some immediate useful purpose, a problem requiring the methods of pure research, but which pure research has hitherto neglected. The disdainful pose is very seldom found among truly great research men.

There are a few geniuses in every generation who may well be allowed to roam fancy-free in the realm of research, but there are more of those who try to be geniuses but are really intelligent plodders, capable of much useful detail work but only at rare intervals, if at all, of pioneering. If such investigators in pure science have their studies guided by an engineering mind into those paths that seem likely to lead somewhere, industry can use their efforts to great advantage. Indeed, the pure science by-products of the oriented research of industry are today adding more to fundamental knowledge than is the pure science work carried on with no conscious hope of application.

Industry cannot and should not pay for research that is carried on *solely* for the mental enjoyment of the investigator. While such investigations may, in spite of the mental attitude of those who make them, ultimately lead by devious routes and after many years, to commercially useful results, the return is to posterity rather than directly to those who financed them.

Research that seeks to build up information for the use of posterity is primarily the function of the state and of endowed institutions, not directly that of business.

Research for profit's sake

So let us turn to those types of research that may be expected to bring a direct or indirect return within some reasonable time.

Utility of negative results

It may be necessary to find out facts hitherto unknown, just to find out what the facts are, without deliberate intention of using them in a positive fashion, but merely to tell industry how to trim its sails. A firm may wish to know in great detail the properties of its product that have not hitherto been determined, in order to tell what new fields it might enter, or what are the ones in which it cannot permanently compete.

The possibilities of competing materials may have to be studied with no idea at all of producing them. A process may be under development on which no economic balance can be struck until it is known how cheaply or how uniformly the product can be made.

As Becket[4] points out, it is often possible to avoid wasting money in research by first making calculations that will reveal that by no reasonably attainable efficiency would the product be cheap enough to compete, even though all technical "bugs" were eliminated, but there are often border-line cases where one must carry the work almost to technical completion before a decision can be made either to drop the idea as uneconomical or to carry it through to a finish. Such research, if dropped as soon as it has shown that it will not pay to carry it further, can be classed as a money-saver rather than a money-maker, for it avoids further expense. Examination of inventor's dreams, schemes of friends of the management, plans of non-technical executives, all in the cold light of fact, and prior to purchase of patent rights or of special equipment and the erection of plant additions to house it, may be technically just as difficult as any other type of research, and may be highly successful even though the work leads to no production, no improvement and to nothing whatever except avoidance of useless expenditure. Negative results, obtained in time, may be thoroughly successful. The development of methods for utilization of new sources of supply of raw materials not amenable to present methods of utilization, may serve as an insurance policy that can be called upon should the present supply fail or its price be raised to such a point that the alternative source plus the extra cost of its utilization could compete economically. Without such a safeguard, investment in plant extensions or improvements might be wholly unwarranted. The new method may never be used, but its existence allows long-time planning. Such work may make money, even though it does so very indirectly.

The research point of view in solution of plant difficulties

The direct money making type of research may refer to improvement of present products and methods or to development of new ones. Trouble-shooting, remedying causes for customer complaints, improving production methods and cutting production costs, instituting inspection methods for control of quality, etc., may just be engineering, the application of known facts to a situation in which they have not hitherto been applied (and they ordinarily fall into that category), but at time they may involve finding unknown facts and working matters out by the methods of true research. "Epidemics" of plant troubles that come and go without anyone knowing why they came or why they disappeared, generally call for the application of research ability of a high order to segregate and control the actual causes.

Specification research

A special subdivision of present-product research is what may be termed "specification research" aimed to correlate and unify testing and inspection methods and bring forth an acceptable common denominator for evaluation of quality. This type normally demands joint, rather than individual, action.

New-product research

Finally, we come to creative, new process and new product research, definitely undertaken with the idea of making money by production of something not made before or with qualities not hitherto possessed, or by means not previously used. The starting point for such research is either a clearly defined need or an idea that some new thing, that is visualized as possible to produce, will fill a present or future need. A *market* for the results of this type of research is a prerequisite to success. Unless the basic technical facts are brought from the laboratory report stage through the pilot plant "bug eliminator" and finally into full scale production, profits do not result. Capital for development, engineering to put it on a plant scale, publicity, and marketing ability are all required. A pigeon-holed report

(Continued on page 22)

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[1] C. F. Kettering. Address before American Iron & Steel Institute, May 1933, *Daily Metal Trade,* May 26, 1933, pages 5, 8.

[2] L. W. Chubb. Talk before Engineering Society, Western Massachusetts, May 16, 1933.

[3] Anon The Queen of the Sciences (Mathematics). *Power Plant Engineering,* June 1933, page 247.

[4] F. M. Becket. An Opportunity for Conservation. Presidential Address, *Transactions American Electrochemical Society,* Vol. 49, 1926, pages 17-27.

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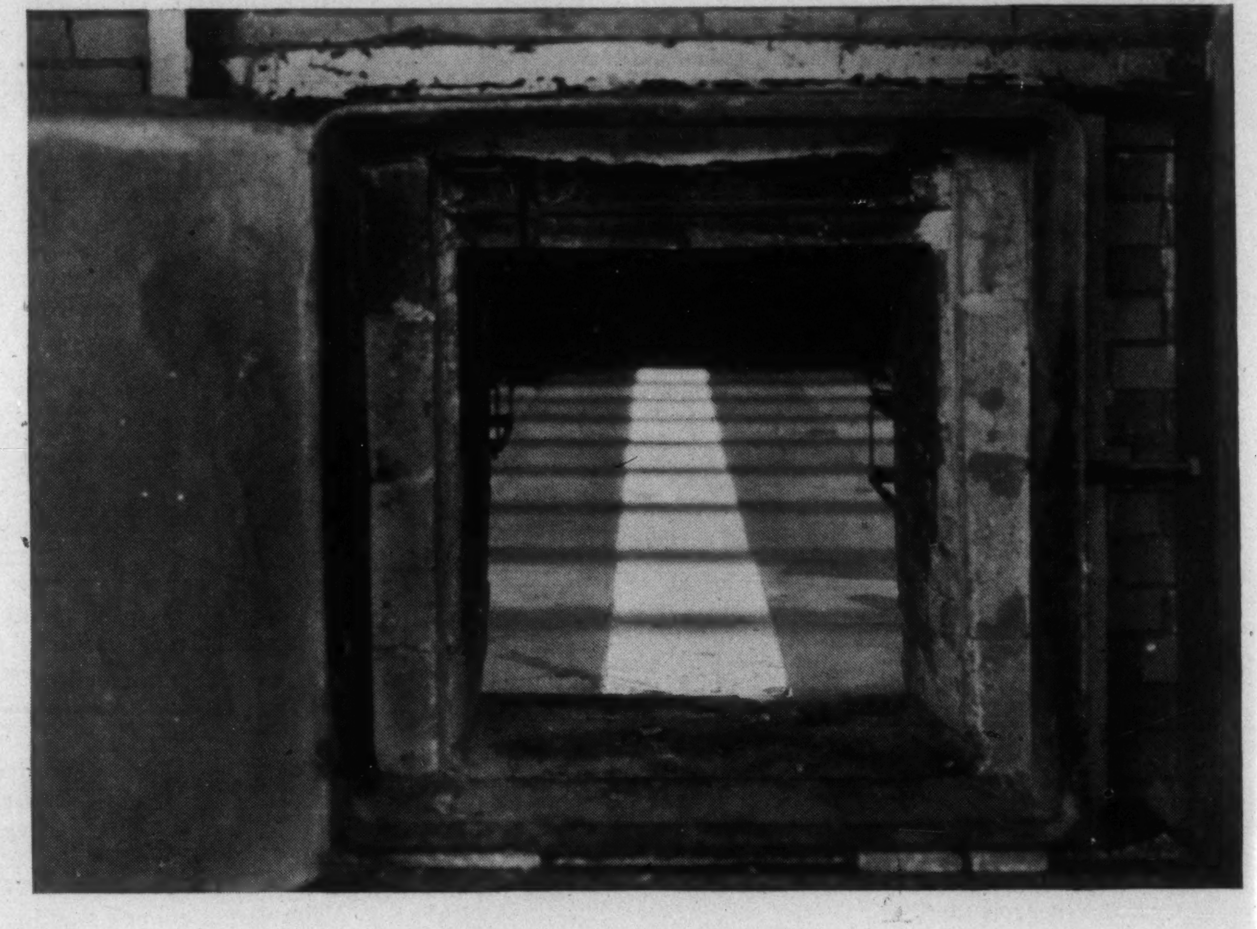

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Some Metallurgical Aspects of the Present Production of STEEL AND Other FERROUS CASTINGS

By R. A. Bull*

Pouring of a Mold from a Geared Crane

A MULTIPLICITY of alloys of slightly varying composition, all used to meet the same type of service, is a thorn in the flesh of any producer and raises costs to the maker and user. Such a situation in the red brass foundry industry is being combated under the leadership of Dr. G. H. Clamer. But, as Major Bull points out, there is an increasing tendency to play the changes on the alloying elements so as to fit the alloy exactly to its job. For example, the Aluminum Company of America has done this in the development of alloys specially suited to resist repeated stress. The International Nickel Company, the Vanadium Corporation of America, and the producers of molybdenum are constantly confronted with the necessity of finding out how these expensive elements can be so assembled with others into complex alloys in such combinations as to bring the maximum beneficial effect at the lowest percentage of costly metal, realizing that a little alloying element in many tons of complex alloy makes for the broadest market.

Even the cheaper alloying elements, such as Cr, Mn, Si, and Cu, are being used in carefully graded amounts and only in such amounts as are really required by the service in hand. Tailor-made steels are the order of the day, even in the very cheap ones.

Moreover, we are coming to appreciate that there is no huge gap between steel and cast iron in response to alloy content. While we have not yet gone very far beyond Ni and Cr in alloy cast irons, it is obvious that before long practically the whole range of alloying elements for steel will soon find their places in cast and malleable irons.

This offers an opportunity for increased utilization of small, flexible furnaces, and since these are increasingly being made use of, especially by the foundryman, the feasibility of utilizing the whole periodic system, even the more rare and expensive elements, in alloy-building will increase. We are no longer playing on a three-stringed Japanese samisen but are learning to play a pipe organ with many stops and several key boards.

Taking the long view—as Major Bull always does—this means that the problems of purchase specifications and of metallurgical terminology will become more complex and should be tackled before they get out of hand.

We already have some interesting cases of terminology. Take the "high-carbon, high-chromium" tool and die steels, which scarcely fit the usual definition of steel but, being forgeable, are pretty generally so classed. Then we have the new alloys for cast automobile camshafts and crankshafts which some of the descriptions call "high-carbon, low-alloy steels containing some graphite," but which most metallurgists would call high-strength alloy cast irons. On the other hand, washed metal has been experimentally hot-rolled, and we hear hints of the hot-working of various cast irons, so that the features by which steel and cast iron are normally differentiated tend to become less marked.

We are obviously faced with alloy complexity; let's do what we can to simplify our metallurgical classifications and nomenclature and to keep specifications sensible and yet sufficient.

WHILE advancement in producing industrial metal products necessarily is followed by progress in preparing higher purchasing standards, occasionally there is an appreciable lapse of time between important manufacturing developments and the establishment of appropriate specification requirements. Sometimes these delays result in private specifications, which may retard progress in desirable standardization when they contain improper or unique requirements for widely produced materials. Some comments regarding recent accomplishments and the existing situation in respect to steel and other ferrous castings may help to prevent errors in demanding material conforming to improper requirements, extend the selective use of castings according to the demonstrated typical properties of the several metals, and place the foundry industry in its proper light, viewed from the standpoint of metallurgical achievement.

In the ferrous foundries heat treatment has come in for a large share of the experimental work done during the last decade. Naturally much of the research into cast steel has also covered a very wide range in chemical composition. A great deal of the resulting progress is reflected in new purchasing requirements issued by the American Society for Testing Materials, for steel, malleable iron, and gray-iron castings. Advancements in making the copper and light metal alloys have been quite as significant as those related to iron-bearing metals. Briefly, the entire foundry industry seems to some consumers to have taken very recently a new lease on life, metallurgically speaking. But this has resulted from efforts exerted for about ten years before consumers generally were aware of them.

New Metal Grades Call for Revised Terminology

The term gray iron as used above is employed generally to identify all those varieties of cast iron that do not lie within the malleable classification. This comment prompts another, of related but more general significance. Commercial manufacture of metals, as the combined result of careful research, crude experiment, and mere

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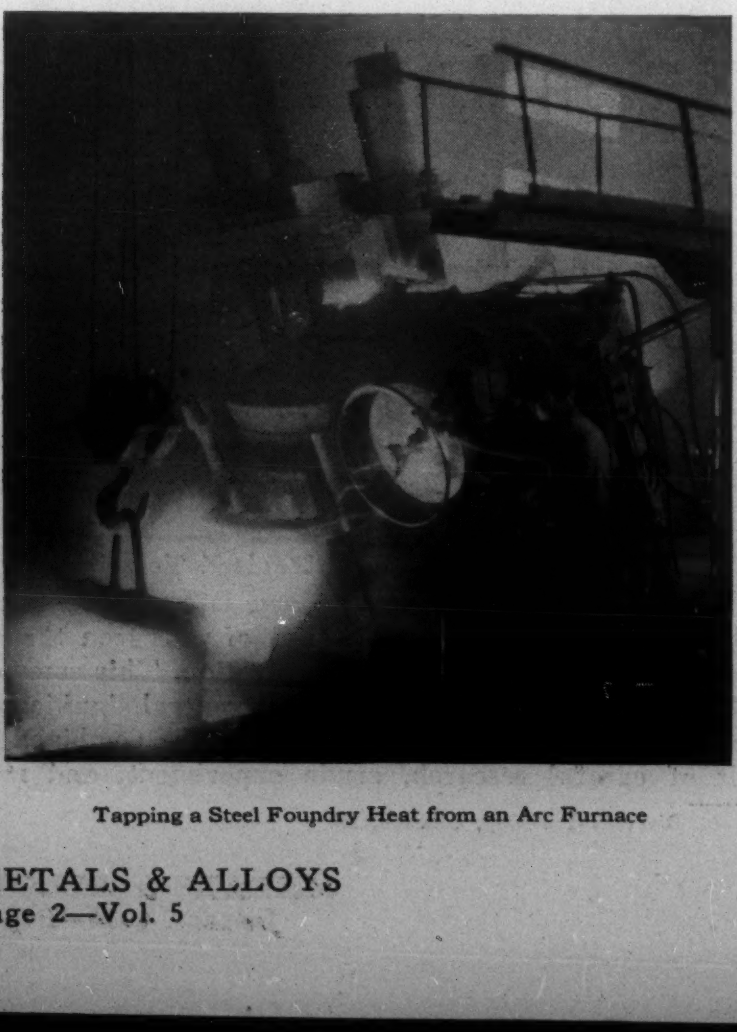
*541 Diversey Parkway, Chicago, Ill.

guess-work, has outstripped satisfactory metallurgical nomenclature. Thus it happens that the iron foundry industry is confronted now with the need for a new term to be substituted for "gray iron." In its true meaning the word "gray" no longer is applicable to every grade of cast iron that is not of the malleable variety. It is well known that important grades of the material are being regularly made which are neither gray in fracture nor malleable. And within the last few years certain cast irons have been produced which some designate as "semi-malleable," possessing some degree of malleability accompanied by strength values exceeding those characterizing the regular malleable variety.

The difficulties of definition and classification have not been confined entirely to the cast irons. The marked interest of industrialists in wrought and cast products having compositions resisting corrosive attack and deterioration under conditions of high temperature, have led to differences of opinion as to whether certain ferrous materials should be called steel. At present there are a number of varieties of foundry metal in which the percentage of iron, roughly, amounts to about half of all the constituents. When the iron content is less than 50%, shall we call the material a ferrous metal? Perhaps the dividing line should not be drawn on a strictly arithmetical basis, but on that of the major characteristic of the finished material—if a predominant feature can be agreed on.

Of course the vital problem is not one of universally accepted nomenclature. Nevertheless there is need for authoritative metallurgical definitions, largely but not wholly for the guidance of consumers. It is obvious that definitive efforts should be made by joint action of the several societies whose activities are related to metallurgy. It is equally evident that definitions to survive technical progress should be devised by men who have considerable imagination, and who can speculate logically regarding developments yet to be achieved.

Probably the lack of satisfactory old terms for identifying newly originated grades of metal has been partially responsible for the growing and confusing tendency of manufacturers to give fanciful trade names (sometimes copyrighted) to their particular products. In view of the necessity for individual identification one cannot justifiably censure the makers concerned for exploiting what they produce under names that occasionally seem fantastic. Often, of course, the same material has several names, each inflicted on it by a different producer. Generally the trade-names are self-indicative of nothing significant to metallurgists in the service of consumers, barring their occasionally manifested confidence in a label demonstrating the manufacturer's idea of quality. But that means nothing to the consumer who demands proof. The tribe of those who require to be shown is increasing, fortunately for the conscientious producer.



Tapping a Steel Foundry Heat from an Arc Furnace

Differences in Analyses of Cast and Wrought Products

These comments regarding nomenclature are offered with the hope that the growing interest in this subject may be stimulated to the point of prompting joint technical society action for the benefit of all concerned, but chiefly in the interests of the consumer. Speaking as one who has long been connected with the steel casting industry, the author would point out that attempts to distinguish between certain varieties of steel should be made with knowledge of the fact that steel mill practice frequently differs from steel foundry practice in respect to the percentages of manganese and silicon, particularly the former. Ranges of composition proposed for differentiation between carbon steel and alloy steel could slightly differ consistently for castings, from ranges for material to be rolled or forged. Although this fact is not realized by many consumers, there is an understandable reason for it. The steel foundryman is confronted with the necessity for having at all times sufficient quantities of manganese and silicon to assure satisfactory deoxidation of the steel. Obviously the foundryman's product, on solidification in the sand mold, should be free from gas cavities, as well as shrinkage cavities. On the other hand, the presence of cavities in the ingot does not necessarily presuppose the existence of any actual cavities in the product made from the metal in the ingot. Pressure exerted in rolling or forging may be attended by a welding action, effective in variable degree (dependent on existing conditions of temperature and on the characteristics of the cavity).

Chemical Classification of Foundry Steels

The effort to provide by means of analysis ranges, acceptable terminology, etc., accurate designations of the many varieties of metal produced in steel foundries should of course include what are called the high alloy grades (a few of which in cast form are of such composition as to induce some metallurgists to call them irons rather than steels). It is a step farther in the same general direction to attempt to differentiate between the high alloy steels and the low alloy steels, between which there is now no generally recognized dividing line. But the logical first (and easiest) step is the establishment of a basis for distinguishing between low alloy steel and carbon steel.

These efforts would not be as academic as might appear, at first thought. The author believes that such differentiations would be in the interest of purchasers, some of whom unquestionably are now perplexed when they attempt to determine whether the material offered by one manufacturer is a complex alloy or a simple alloy steel, or whether it is an alloy steel or a carbon steel; and whether pricing is done justifiably on the basis of special composition causing extra manufacturing expense.

Recognizing some of these difficulties, particularly those that apply to steel casting practice, in 1931 the author presented a paper before the American Foundrymen's Association, suggesting for consideration (but not advocating for adoption) a basis for classifying casting steels according to their chemical composition.* The resulting discussion finally prompted the appointment of a committee of the A.F.A., instructed to consider the subject thoroughly and submit recommendations. This committee has taken its job seriously, in the effort to establish chemical boundaries for each of a number of groups of casting steels; also in seeking an identification system by means of which any particular variety of casting steel within a group might be designated briefly and satisfactorily, if and when the purchaser elects to specify composition within a certain range, while naming minimum physical properties that must be met. The latter task proved to be very difficult.

Great Composition Variety in Cast Alloy Steels

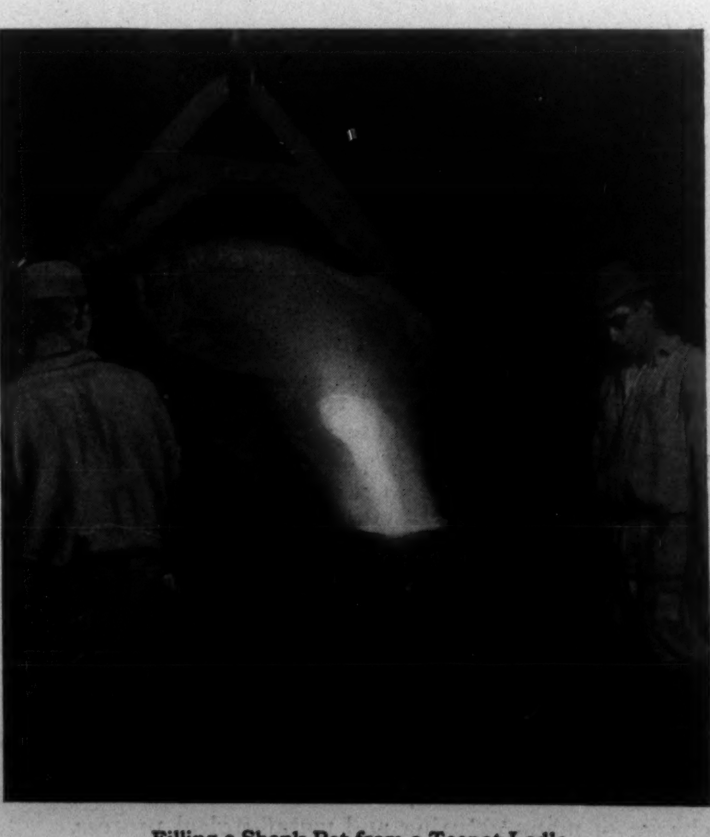
Without risking criticism for improperly giving advance information that may be published in the A.F.A. committee's report (which may be agreed to in time for inclusion in the Cast Metals Handbook, expected to be published in 1934 under the sponsorship of the American Foundrymen's Association), the author feels privileged to say that a difficult problem has confronted the committee, due to the very large variety of alloy steels now being produced for castings. There appear to be not less than 75 such grades of metal which are being more or less frequently and intentionally produced, evidently with the thought that each such variety is best adapted for one or more purposes. It would seem that there is a considerably larger variety of such cast steels being made than may be produced a few years hence, when more experience in foundry technique, in heat treatment, in laboratory testing, and in service behavior is obtained. Undoubtedly there will be developed within the next 10 years entirely new combinations of casting steels of distinct advantage, while some varieties now manufactured will be discontinued. Meanwhile, the steel casting industry, largely speaking, is in the interesting stage of trial and error, in its somewhat recently developed state of alloy-consciousness. And it appears that the situation in considerable degree (but not to the same great extent) prevails in other branches of steel manufacture.

This affords, *per se,* no basis for indictment against steel producers. While one would be foolish to discount, generally speaking, the indications of serviceability obtainable from laboratory tests, those men who are most familiar with such tests are more positive than are some other people in declaring that laboratory tests fail to supply much valuable information regarding behavior in service. The time element is a tremendous factor affecting the serviceability of a metal part, under any conditions of mechanical stress or resistance to corrosive and other relatively destructive agencies. Creep testing presents one of the most significant laboratory attempts to duplicate these time factors incidental to service.

The difficulty of conducting laboratory tests to establish data for design purposes is not the only one that has resulted in so many grades of alloy cast steel now being produced. It must be remembered that during the last 15 years many electric melting furnaces have been installed in foundries, providing conveniently small units for the manufacturing of special steels often ordered in light tonnages. Thus, the typical electric steel foundry occupies a position in respect to special metals which is much more promising than that held by the average open-hearth foundry. And while the resulting great number of steel varieties serves temporarily to cause some confusion in the present significant stage of casting production, the outcome promises to be helpful to everybody concerned; partly because there is being demonstrated much more forcibly than ever before, the extraordinary flexibility of the foundry product. This flexibility, considered in respect to shape, has of course been widely recognized through many centuries. But the variety in physical properties obtainable in the foundry was not realized generally by engineers up to a few years ago, and is not fully appreciated now. (Incidentally, it cannot be denied that the striking developments in the welding art gave the foundryman an enormous stimulus to develop improvement in casting properties.)

Many Property Combinations Now Available in Ferrous Castings

This flexibility or versatility in foundry metal, while naturally most pronounced in steel, is by no means confined to that material, even when it is of a grade giving rise to no dispute in respect to terminology. This may be better appreciated by mentioning recent developments in Testing Society specifications for ferrous castings. Without differentiating between the tentative standards and the established standards that have been adopted by the A.S.T.M., it is interesting to note that there are now "on the books" of the Testing Society specifications for seven grades of gray iron, ranging in minimum tensile strength requirements from 20,000 to 60,000 lbs./in.^{2}; specifications for 2 grades of malleable iron, calling respectively for 50,000 lbs./in.^{2} tensile strength and 10% elongation, and 53,000 lbs./in.^{2} tensile strength and 18% elongation. It seems likely that another grade of malleable iron will ultimately be included in A.S.T.M. specications, calling for relatively low values that are regarded as entirely suitable for certain products. A fourth grade of malleable iron not infrequently produced, but not covered in an A.S.T.M. specification, has a materially higher tensile strength than has been mentioned, and (naturally) a fairly low ductility.



Filling a Shank Pot from a Teapot Ladle

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*Chemical Composition as Employed for Classifying Carbon and Alloy Steels for Castings. *Transactions of American Foundrymen's Association,* Vol. XXXIX, 1931, page 257.

Continuing the summary, there are now 5 grades of carbon steel, one grade of Austenitic steel, and 8 grades of ferritic or pearlitic structural steels covered in Testing Society specifications for castings (the strongest being required to have not less than 150,000 lbs./in.^{2} tensile strength and 25% reduction of area). And the end is not yet. To be specific, a Testing Society committee is now vigorously at work in developing specifications for alloy steel castings for service at temperatures up to 1100° F., which are expected to provide for additional grades of metal. What may be expected in respect to stainless steel casting specifications is still another story. Such A.S.T.M. purchase requirements may be expected soon.

A few contrasts will bring the existing condition of cast metal flexibility into proper perspective. Whereas 10 years ago there probably were not more than 4 grades of cast iron (including gray, white, mottled, malleable, and semi-malleable varieties) produced in appreciable tonnages in this country, there are now at least 11 grades of metal often put into iron castings, each having many useful applications. And whereas A.S.T.M. specifications previous to 1930 provided but 4 carbon grades and no alloy grade of cast steel, now the specifications published by the Testing Society cover 5 carbon grades and 9 alloy grades. The alloy cast steel specifications recently developed represent merely a beginning in the establishment of purchasing standards that may be used for the steadily increasing special product of the steel foundry. The proportion of alloy cast steel to total cast steel grew from a little over 6 to 19% in the 10 years ending with 1932.

Naturally one result from these striking developments in manufacturing ferrous castings is the expenditure of much time and effort to obtain agreements on rejection limits for specifications. Another effect is the present confusion in terminology, previously mentioned. It also happens inevitably that what may be called the twilight zones, wherein more than one foundry metal might be used satisfactorily in service, are expanding. Gradually each general class of foundry products is acquiring a closer competitive relationship with each other class. And as one consequence of all of this achievement, the welding advocate now gets a stimulus from the foundryman; thus to some extent reversing the order of things that aroused the casting maker a few years ago. Obviously, all of the developments that have been indicated have worked to the distinct economic advantage of the consumer-class.

T. D. Lynch

Tillman D. Lynch, aged 66, formerly consulting metallurgical engineer, at the Westinghouse Electric & Manufacturing Co., died at his home in Edgewood, Pa., after several months illness. Mr. Lynch, who recently retired from active duties, was one of the best known metallurgical engineers of the United States and a past President of the American Society of Steel Treating. Born in Harrison County, W. Va., in 1867, he graduated in 1891 from the Virginia University with the degree of Civil Engineer. Upon graduation, Mr. Lynch joined the contracting and inspecting engineering firm of G. W. G. Ferris and Company of Pittsburgh, Chicago, and New York, doing inspection work at mill, foundry, shop and field erection. During 1895 to 1897 he had charge of the Chicago office of the firm. From 1897 to 1899, the period of the Spanish War, he was in the Bureau of Steam Engineer, United States Navy. He joined the Westinghouse Company in 1899 and was with this company continuously until his recent retirement, principally being in charge of manufacturing and metallurgical process.

C. L. Anger Joins Udylite

According to an announcement from L. K. Lindahl, General Manager of the Udylite Process Co., Detroit, C. L. Anger, well-known plating engineer, has joined the Udylite staff. Mr. Anger's headquarters will be the recently established Cleveland Branch office of the Company. Mr. Anger brings to Udylite broad experience in the plating industry. Shortly after graduating from the chemical engineering department of the University of Michigan in 1919, he made his initial entry into electroplating by entering the employ of the C. G. Spring & Bumper Co., Detroit. Here Mr. Anger was in charge of finishing and chemical processes including plating, rustproofing, polishing, enameling and heat treating departments. Following his connection with C. G. Spring & Bumper, he became associated in turn with O. M. Hall Lamp Co., General Chromium Corp., and Detroit Plating Industries. His positions with these concerns were similar to that held at C. G. Spring. In 1929, Mr. Anger left Detroit Plating Industries and made his first connection with a plating supply house when he joined the Chicago office of The Hanson-Van Winkle-Munning Co. as service engineer. After serving one year, he continued in the latter capacity prior to joining Udylite. For the past few months, Mr. Anger has been working on special plating problems in the Udylite laboratories. The opening of the Cleveland Branch office finds Mr. Anger prepared by experience and training to render assistance to customers in that vicinity.

Please Note

In the October issue of Metals & Alloys in an article by R. A. Smart the name of the builder of the furnace illustrated on page 155 was omitted. This large normalizing furnace was built by the Electric Furnace Company, Salem, Ohio.

Metallurgy of Watch-Making

H. W. Gillett, director of Battelle Memorial Institute, Columbus, Ohio, has announced the establishment at the institute of a research project sponsored by the Elgin National Watch Co., Elgin, Ill., for the study of the metallurgy of watch-making. Various alloys are used in watch parts, but they have remained the same for many years. Metallurgical advances that other industries have developed and applied have been singularly lacking in the horological industry. Improvement and standardization of the metal in watch parts are the primary aims of this project. The Elgin National Watch Co. in the spirit of the word "national" in its name, has developed the manufacture of its own parts rather than relying on foreign sources. It is thus in a position fully to utilize metallurgical research developments and to work out new alloys especially fitted to meet their particular requirements. James L. Gregg and A. W. MacLaren, metallurgists, and H. W. Russell, chief physicist, have been designated by Doctor Gillett to work on this research program.

"Silicosis"

In view of the increasing prominence given to the effects of silica dust on the health of workers, the Industrial Health Section of the Metropolitan Life Insurance Company has prepared a booklet entitled "Silicosis" for the information of plant superintendents and foremen in departments where silica dust is present. The booklet might be of aid in controlling dusty processes arising in the course of manufacture.

Copies of the booklet are available. Requests may be addressed direct to the Industrial Health Section, Metropolitan Life Insurance Company, One Madison Avenue, New York City.

Litle with Detroit Electric Furnace

The Detroit Electric Furnace Company, manufacturers of rocking electric furnaces, has retained T. J. Litle, Jr., as engineering counsel on electric cast iron in the automotive industry. Mr. Litle was formerly engineering executive at both the Lincoln and Marmon Motor Car Companies, as well as President of the Society of Automotive Engineers.

VACUUM FURNACES
IN METALLURGY

N. A. Ziegler*

It is surprising that vacuum furnaces have as yet made so little headway in commercial metallurgy in this country. The high frequency furnace, which would be used in vacuum processes, has become a commercial commonplace with many operators familiar with handling it.

Way back in August 1929, Vol. 1, page 72, we published an editorial, "Vacuum melting for quality steel—why not?" The arguments there set forth seem to us as good today as they seemed then, and laboratory experience with vacuum furnaces has, of course, gone much farther in that period.

Perhaps the trouble is that when the operating man strolls into the laboratory and sees a vacuum furnace, he sees a maze of glass tubing on the vacuum line and supposes that any vacuum outfit would be fussy and fragile, which is, of course, not the case.

PURITY of the product always was and still is one of the most important considerations in the making of alloys and has had a tremendous influence on the development of all metallurgical processes. Taking as an example metallurgy of iron; some 30 years ago 99.9% pure iron was a laboratory curiosity, while at present it is being prepared commercially in open hearths, and yet even this product is far from being pure iron.[1]

One of the factors which interferes with the purity of metallurgical products, and which is occupying the attention of all conscientious alloy workers, is the reaction of the hot charge in a metallurgical furnace with the atmospheric gases. When a metal is melted (or sometimes even heated up in the solid state) in any atmosphere, a reaction may be expected between the metal and the gas (or gases). It may be a simple mechanical "sorbtion" of gas bubbles, or it may be a liquid or solid solution, or a chemical reaction, either with the principal metal, or with the ingredients present. In the finished product materials resulting from these reactions may be present in a variety of different states, and may have very different influences on its properties. The interest and at the same time ignorance (quite frankly admitted by many) on this subject were very well manifested at the symposiums on gases in metals held for the last two years by the American Institute of Mining & Metallurgical Engineers. During the last symposium, Prof. Mathewson, in a very able and remarkably clear way, demonstrated the complexity of these problems, and the difficulties which have to be faced by anyone working in this field.

In many cases reactions of different metals with the gaseous phases are taken advantage of, and are successfully applied for the purification of various alloys. Taking as an example the process of preparation of steel from pig iron; the main reaction here is the combination of carbon with the atmospheric oxygen. (There are other equally important purifying reactions, but for the moment they may be disregarded.) This reaction may be expressed by the following equations:—

$$\begin{aligned} C + O_2 &\rightleftharpoons CO_2 \\ 2\,C + O_2 &\rightleftharpoons 2\,CO \\ Fe_3\,C + O_2 &\rightleftharpoons 3\,Fe + CO_2 \\ 2\,Fe_3\,C + O_2 &\rightleftharpoons 6\,Fe + 2\,CO^{**} \end{aligned}$$

At the same time as carbon is being oxidized, reaction of oxygen with the iron is in progress, which process may be represented by the following equations:

$$\begin{aligned} 2\,Fe + O_2 &\rightleftharpoons 2\,FeO \\ Fe + CO_2 &\rightleftharpoons FeO + CO \\ 2\,Fe + CO_2 &\rightleftharpoons 2\,FeO + C^{\dagger} \end{aligned}$$

By adjusting the relative amounts of phases participating in the above reactions, the equilibrium between Fe, O_2, Fe_3C, FeO and CO can be shifted at will in any direction. A skillful steel maker knows with a fair degree of accuracy where to stop, in order to obtain the final product sufficiently low in carbon, and at the same time not oxidized too far.‡

However, no matter how skillful he is, he inevitably will have in the final product a certain amount of carbon, which he may or may not want, and a certain amount of oxygen, in one or another form, which is almost always undesirable. It is absolutely impossible to prepare iron in an ordinary atmosphere so that it will be substantially free from both carbon and oxygen. Amount of one can be reduced only by increasing the amount of the other. The only way to bring the above reactions to a desired completion is by eliminating the atmosphere around the bath, and by continuous removal of gaseous products of reactions (CO and possibly CO_2), occurring in the bath.

Supposing that the atmosphere over the molten bath should be gradually removed, the reaction $2C + O_2 \rightarrow 2CO$, will progress in the direction indicated, with a new equilibrium existing for every pressure, thus allowing us a simultaneous removal of C and O_2 from the bath. This is the principle often applied to the preparation of "pure" metals (in particular iron), and which in certain cases may be equally well adopted for the purification by annealing.

Before going any further, it would be well to define the frequently used word "vacuum." It should be understood that there is no absolute emptiness in nature. According to Edington and Jeans, even in the interplanatory and interstellar space several atoms of matter are present in every cubic centimeter. In the best vacuum obtainable in the laboratory, there are about ten billions of atoms per every cubic centimeter of space, which corresponds to a vacuum of one hundred-millionth millimeter of mercury. Even this relatively crude vacuum can be produced only in small glass vessels by means of very elaborate pumping systems, and cannot be used for any metallurgical processes, no matter how small. In the common language, however, by "vacuum" are understood all pressures below one atmosphere, the application of which, to metallurgical processes, is increasing every year. Which is the poorest vacuum (or the highest pressure) which begins to improve the product is impossible to specify, because it varies with conditions. In certain laboratory work, vacuum of at least .001 mm. mercury should be obtained to secure the desired results. On the other hand, in commercial practice, according to Rohn (as will be discussed later), a vacuum of 5 mm. mercury is sometimes sufficiently high to serve the purpose.

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*Westinghouse Research Laboratories, East Pittsburgh, Pa.

**It is assumed for the sake of simplicity that there are no other carbides of iron present.

†Again for the sake of simplicity, it is assumed that FeO is the only oxide formed, which is not true.

‡It should be pointed out that the actual process of steel making is much more complicated. Perhaps hundreds of equations could be drawn, representing reactions taking place in an open hearth bath, but for the purpose of the present paper, the above outline is sufficiently complete.

An electric furnace is the only one which can be successfully converted into and be used as a vacuum furnace. With perhaps very few exceptions, unknown to the author, all vacuum furnaces are electrically heated. Very generally they can be divided into: Commercial and laboratory, induction and resistance, and melting and annealing.

Until very recently, a vacuum furnace was purely a product of laboratory research development, and at present there is not a well-equipped metallurgical laboratory in which vacuum furnaces are not used. All laboratory vacuum furnaces can be divided into two general groups: those heated by resistance, and those heated by an induced field.

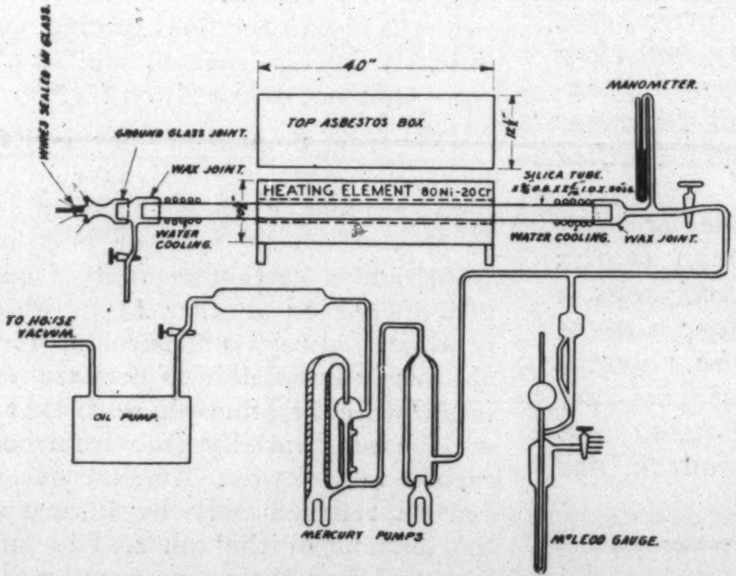
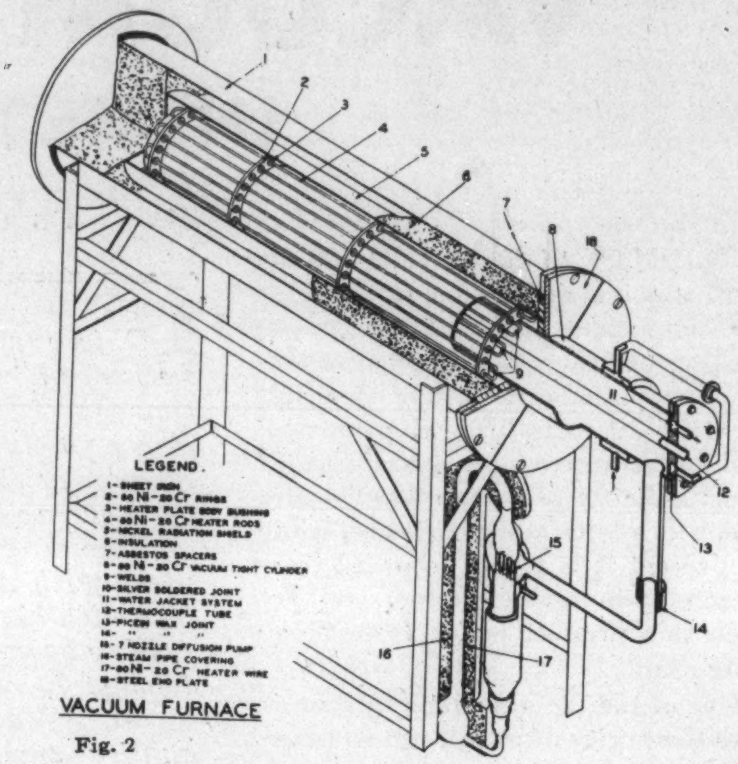

WIRES SEALED IN GLASS.
40"
TOP ASBESTOS BOX
12"
MANOMETER.
GROUND GLASS JOINT.
WAX JOINT.
HEATING ELEMENT 80NI-20CR
SILICA TUBE.
WATER COOLING.
WATER COOLING.
WAX JOINT.
TO HOUSE VACUUM.
OIL PUMP.
MERCURY PUMPS
McLEOD GAUGE.

Fig 1. High Vacuum Annealing Furnace

The simplest resistance vacuum furnace is a silica tube with one end connected to the vacuum pumps, the other provided with a vacuum tight cover, and a metallic heating element wound on the tube. A characteristic furnace of this type is given in Fig. 1, which is self-explanatory. This furnace can be used at all temperatures up to 1100°C., above which the heating element oxidizes very rapidly, and the silica tube cannot withstand the atmospheric pressure. A vacuum is produced by mercury pumps and an oil pump in series, and can be maintained at or below .001 mm. mercury for an indefinite period of time. The vacuum system is constructed exclusively of silica, glass and vacuum cement, down to the oil pump. Furnace temperature is measured by a thermocouple attached to the wires sealed into the glass front cover.

At Westinghouse Research Laboratories this furnace is used for annealing purposes only, but any metal or alloy with a melting point lower than 1100°C. could be fused in it. For melting purposes, it would probably be more convenient to have the silica tube placed in a vertical position, with the lower end permanently sealed. and having the ground glass cover and the vacuum connection on the upper end. If a material which could withstand atmospheric pressure, and a heating element which could withstand oxidation at temperatures over 1100°C. could be found, the field of application for this type of furnace would be considerably enlarged.


1
2
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18
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16
17
LEGEND.
1-SHEET IRON
2-80 Ni-20 Cr RINGS
3-HEATER PLATE BODY BUSHING
4-80 Ni-20 Cr HEATER RODS
5-NICKEL RADIATION SHIELD
6-INSULATION
7-ASBESTOS SPACERS
8-80 Ni-20 Cr VACUUM TIGHT CYLINDER
9-WELDS
10-SILVER SOLDERED JOINT
11-WATER JACKET SYSTEM
12-THERMOCOUPLE TUBE
13-PICEIN WAX JOINT
14- " " "
15-7 NOZZLE DIFFUSION PUMP
16-STEAM PIPE COVERING
17-80 Ni-20 Cr HEATER WIRE
18-STEEL END PLATE
VACUUM FURNACE

Fig. 2

Recently Dr. Lowry of Westinghouse Research Laboratories[2] very successfully modified this type of furnace by substituting for the silica tube one welded of an 80% Ni, 20% Cr alloy plate ¼ inch thick (Fig. 2). The diameter of the tube was increased to 5 inches, thus very considerably enlarging the capacity of the furnace. Instead of a ribbon wound on the tube, 80% Ni, 20% Cr heater rods are being used, thus making repairs and replacements of the heating element much simpler. The glass front cover is substituted by a water-cooled metallic one, which is more durable. A new design of a powerful mercury diffusion pump is being made use of, thus insuring a vacuum of .001 mm. mercury or better. The maximum temperature obtainable is about 1000°C. Although this furnace is used only for annealing small metallic parts on a semi-commercial basis, by introducing minor changes in its construction, it undoubtedly can be successfully applied for making alloys with melting temperatures of 1000°C., or lower.

In view of the fact that this furnace, without much difficulty, may be considerably enlarged, and judging by very satisfactory working results, it may be considered as a further step in the direction of applying the vacuum for commercial annealing.

There are many vacuum furnaces used in different laboratories for annealing or melting low temperature alloys. Most of them, however, in their main characteristics are similar to the two just described. The real difficulties begin only when temperatures over 1100°C. are required, because there are very few materials known which can withstand atmospheric pressure when heated over 1100°C.* Also, there are not many materials applicable for heating elements, which last for any length of time at those temperatures.** For these reasons, in

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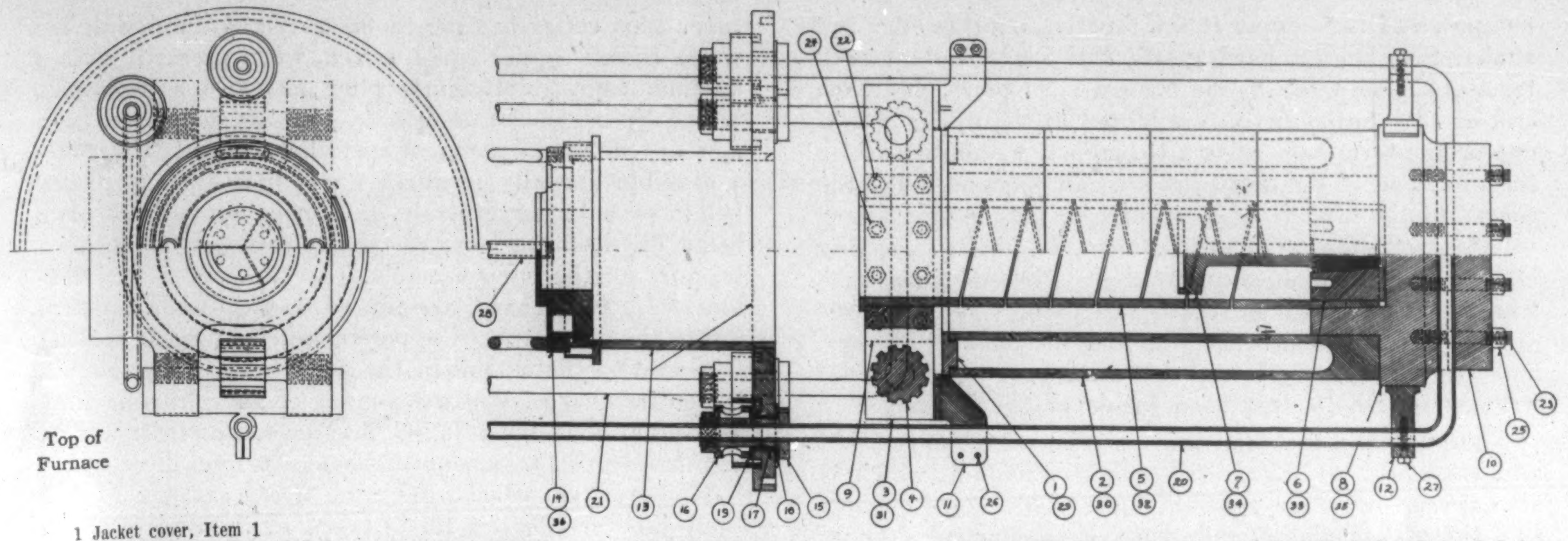
*Most of those that can withstand these requirements have other undesirable characteristics, such as a high coefficient of expansion, causing cracking.

**Those that could be used, such as platinum, are too expensive.


Top of Furnace
28
29
22
19
36
21
13
16
15
17
18
15
9
3
31
4
11
26
1
25
2
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6
33
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35
12
27
10
25
23

1 Jacket cover, Item 1
2 Graphite jacket, Items 1 & 2
3 Top clamp, Items 1 & 2
4 Draw bolt
5 Helix, Item 1
6 Expansion clamp, Item 1
7 Pedestal, Item 1
8 Base, Item 1
9 Clamp block, Item 2
10 Base block, Item 1
11 Support for Top Clamp
12 Base support
13 Cover, Items 1 to 4
14 Small Cover, Items 1 to 4
15 Bushing, Item 2
16 Nut, Items
17 Micarta tube, Item 21
18 Washer, Item 17
19 Washer, Item 19
20 Copper tube, Item 16
21 Copper tube, Item 17
22 ⅜x4 Graphite stud bolt
23 ½x¼ Graphite stud bolt
24 ⅜ Graphite nut
25 ½ Graphite nut
26 5/16x¾ M.B. Tap bolt
27 ¼x1½ M.B. Tap bolt
28 3 of ⅜ W.I. Pipe
29 Jacket Cover, Item 2
30 Graphite Jacket, Items 3 & 4
31 Top Clamp, Items 3 & 4
32 Helix, Item 2
33 Expansion Clamp, Item 2
34 Pedestal, Item 2
35 Base, Item 2
36 Small Cover, Items 1 to 4

Fig. 3

designing a resistance vacuum furnace applicable for, say preparation of iron alloys, two main considerations should be kept in mind: (1) the heating element must be in vacuum; (2) the vacuum container must be at or near room temperature.

The best solution of this problem is a furnace of Arsem[3] type, which may be described as a graphite-helix heating element, enclosed in a water cooled iron vacuum tank (Fig. 3). All parts below the cover 13 are enclosed in an iron tank (not shown), which is sealed by means of a vacuum cement to the groove made in the cover, and which in turn is enclosed in a second somewhat larger iron tank with water circulating between the two. A vacuum is maintained inside of the first tank by means of an oil pump. The main difficulty in constructing this furnace is to supply electric current to the helix, because in order to keep the points of contact of the ends of the helix with the vacuum tank cold, very large graphite clamp blocks (3 and 9, Fig. 3) have to be used. A graphite jacket (2, Fig. 3) and a rather elaborate water cooling system are applied to protect the vacuum tank from overheating. The whole furnace is a very clumsy structure with many sealed joints, which, together with a large amount of graphite and refractory material, makes a high vacuum impossible. .01 mm. mercury is about the best vacuum that may be expected even when the furnace is cold, and about .5 mm. while working.* At present, with the introduction into metallurgical activities of heating the induced field, Arsem and similar types of furnaces become more and more of historic interest only, or are used in such cases when the source of high frequency current is not available.

The advantage of the induction furnace is that only conductors, such as metals and graphite, are heated by an induced field. For this reason heat is developed in the charge itself, and the hot region is restricted to a small space.

On the other hand, it is very difficult to maintain by means of an induced field a solid piece of metal at a uniform temperature, due to the non-uniformities of the shape of a metallic sample, and small fluctuations in the field strength. When the charge melts, non-uniformity of temperature distribution disappears, but temperature fluctuations still may be considerable. For this reason, heating by induced field is seldom used for annealing purposes, and its field of application is restricted mostly to melting alloys.** Laboratory induction vacuum furnaces can be divided broadly into two groups: ones in which the induction coil is in vacuum, and ones in which the induction coil is outside of the vacuum vessel, in the air.

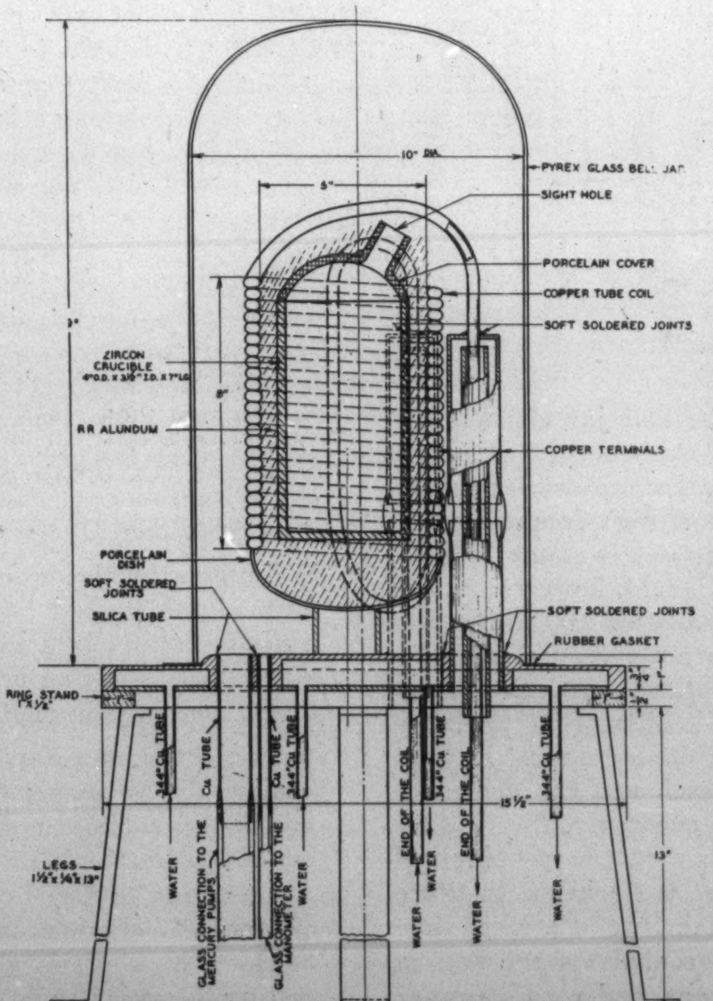
10" DIA.
5"
8"
15½"
13"
PYREX GLASS BELL JAR
SIGHT HOLE
PORCELAIN COVER
COPPER TUBE COIL
SOFT SOLDERED JOINTS
ZIRCON CRUCIBLE 4"O.D. X 3½" I.D. X 7" LG
RR ALUNDUM
COPPER TERMINALS
PORCELAIN DISH
SOFT SOLDERED JOINTS
SILICA TUBE
SOFT SOLDERED JOINTS
RUBBER GASKET
RING STAND 1" X ½"
LEGS 1½" X ¼" X 13"
344" Cu TUBE
Cu TUBE
Cu TUBE
344" Cu TUBE
END OF THE COIL
344" Cu TUBE
END OF THE COIL
344" Cu TUBE
WATER
GLASS CONNECTION TO THE MERCURY PUMPS
GLASS CONNECTION TO THE MANOMETER
WATER
WATER
WATER
WATER
WATER

Fig. 4. General View of the Bell Jar High Vacuum Induction Furnace

The satisfactory solution of the first type is the glass bell jar furnace[4] (Fig. 4). Its main parts are: (1) water cooled steel bottom plate; (2) Pyrex glass bell jar; (3) water cooled copper tube helix, and (4) copper to glass-seals, "terminals."

The most difficult problem in designing this furnace was to bring the ends of the helix from under the bell jar through the bottom steel plate, so as to keep them electrically insulated one from the other, and at the same time to have the joints with the bottom plate vacuum tight. This was solved by introducing two "terminals," each of which is composed of two copper tubes, tapered to a thin edge and sealed together by hard glass. The lower end of each terminal is soldered to the bottom steel plate, and each end of the copper helix is soldered to the upper end of one of the terminals, passes through it without touching its lower end or the bottom plate, and is connected to the source of the high frequency current, thus giving a very satisfactory solution of the problem. The helix is resting on a porcelain dish, supported by a short silica tube which, in turn, rests on the bottom plate. Crucible (usually zirconium silicate), containing the metallic charge, and provided with a high refractory porcelain cover with a sight hole, is placed inside of the helix.

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*Many types of graphite helix vacuum furnaces may be found in literature, but all of them are similar to Arsem furnace, differing only in detail.

**Annealing by induced field is applied to metallic parts of vacuum tubes, each one being treated individually.

The porcelain dish and the space between the crucible and the helix are filled with coarse alundum, which is also spread over the crucible cover. This alundum acts as a thermal insulator, and also as a mechanical support for the crucible. Turns of the helix are insulated, one from another, by placing particles of the same alundum between them. The setup is covered with a Pyrex bell jar, with a rubber ring, both sides of which are greased, placed between it and the bottom plate. The vacuum under the bell jar is produced and maintained by mercury pumps and an oil pump in series. Charges up to 15 lbs. in weight of any metal or alloy melting at or below 2000°C., can be melted in this furnace, and at the same time the pressure under the bell jar can be kept at or below .001 mm. mercury.

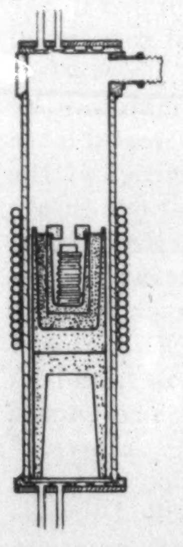

Fig. 5. Vacuum High Frequency Induction Furnace

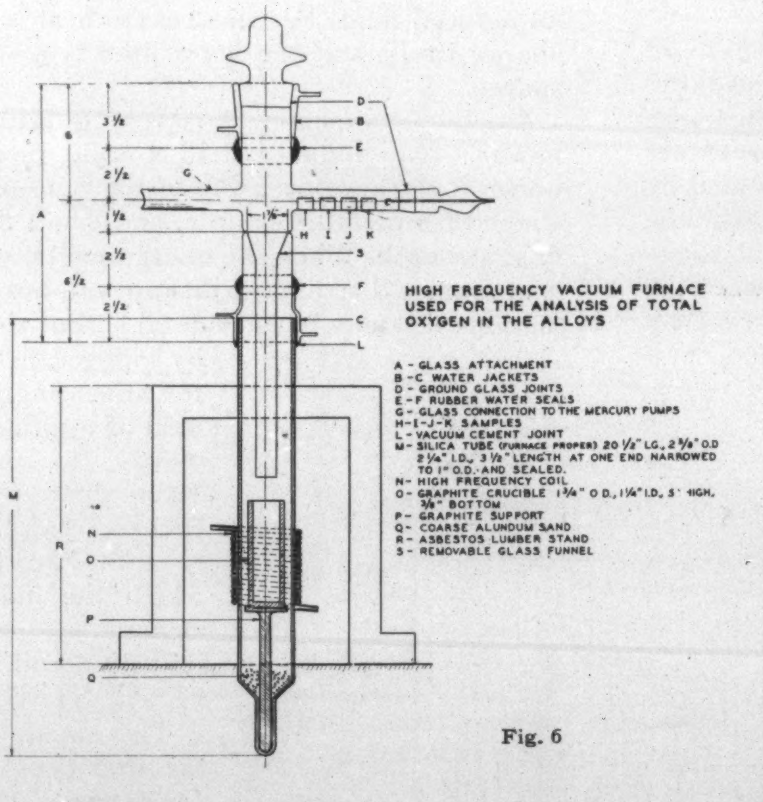
HIGH FREQUENCY VACUUM FURNACE USED FOR THE ANALYSIS OF TOTAL OXYGEN IN THE ALLOYS
A - GLASS ATTACHMENT
B - C WATER JACKETS
D - GROUND GLASS JOINTS
E - F RUBBER WATER SEALS
G - GLASS CONNECTION TO THE MERCURY PUMPS
H-I-J-K SAMPLES
L - VACUUM CEMENT JOINT
M - SILICA TUBE (FURNACE PROPER) 20 1/2" LG., 2 5/8" O.D 2 1/4" I.D., 3 1/2" LENGTH AT ONE END NARROWED TO 1" O.D. AND SEALED.
N - HIGH FREQUENCY COIL
O - GRAPHITE CRUCIBLE 1 3/4" O.D., 1 1/4" I.D., 3" HIGH, 3/8" BOTTOM
P - GRAPHITE SUPPORT
Q - COARSE ALUNDUM SAND
R - ASBESTOS LUMBER STAND
S - REMOVABLE GLASS FUNNEL
3 1/2
2 1/2
1 1/2
2 1/2
6 1/2
2 1/2
1 1/16
A
M
R
N
O
P
Q
G
D
B
E
H
I
J
K
S
F
C
L

Fig. 6

At the Westinghouse Research Laboratories a motor-generator set is used as a source of high frequency current. The maximum output of this set is about 15 KW. at 200 amps. and 12 kilo-cycles. Should, however, a mercury gap oscillator, with a frequency of 100 kilo-cycles or over be used for the same purpose, very strong discharges under the bell jar will follow, which may damage the furnace. Hence, if an oscillator is the only source of high frequency current, the helix must be kept in air, outside of the vacuum vessel, and the design of the furnace should be changed accordingly.

Perhaps the best solution of this problem was obtained by Dr. Walters and his associates at Carnegie Institute of Technology[5] (Fig. 5). They make use of a silica tube type of furnace with the water cooled copper bottom sealed to the tube by vacuum cement, and with a copper collar sealed by vacuum cement to the upper end of the tube. This collar has its upper surface ground with the water cooled copper cover, which, when greased, gives a vacuum tight joint. This collar has also a side hole, which by means of a flexible joint is connected to a mercury diffusion pump. A metallic charge is placed in a crucible (usually magnesia) which in turn is placed inside of a larger crucible, the space between the two being filled with a loose refractory material, acting as a support for the inner crucible. The two concentric crucibles, with the charge, are placed on a suitable pedestal inside the silica tube. Copper-tube-helix (water cooled) is placed on the outside of the silica tube, and surrounds the entire charge. Up to 8 pounds of any metal or alloy melting at or below 1700°C. may be successfully melted in this setup in a vacuum of about .01 mm. mercury.

The relative advantages and disadvantages of the "bell jar" and "silica tube" types of induction-vacuum furnaces are as follows:

In the bell jar furnace—

(a) All flexible and wax joints are eliminated, which reduces considerably the chances of possible leakages, thus insuring a better vacuum.

(b) Larger charges in a better vacuum can be melted.

(c) Charging and cleaning of the furnace is much easier.

(d) Danger of crucible breaking and charge running out is less, because of the crucible being supported by a flexible water-cooled copper helix (also acting as a heating element).

(e) Better coupling between the coil and the charge is secured.

However, as was already pointed out, the drawback of a bell jar furnace is that it can be operated only on a motor-generator set, which is a clumsy and expensive piece of apparatus, while a silica tube furnace may be run on any source of high frequency current.

Another type of a small silica tube high frequency vacuum furnace, used at Westinghouse Research Laboratories, in connection with the graphite vacuum fusion method of determining gaseous elements in metals, is shown in Fig. 6.[6]

At present laboratory vacuum furnaces are not yet commercial products that can be bought in the market, and it is necessary to design and build them individually. In designing a laboratory vacuum furnace, the following considerations may be used as a guide:

1. The field of application:
   a. melting or annealing
   b. temperature range
   c. vacuum range
   d. size and shape of the vacuum vessel
   e. size and kind of the charge
2. Practical restrictions:
   a. money to be invested
   b. source of power available (resistance or induction type; source and quality of the high frequency current, etc.)
   c. source of vacuum (different types of oil and mercury pumps)
   d. access to the services of skillful electricians, mechanics and glass blowers
   e. materials to be used for construction (particularly refractories)

Judging by the information to be found in the literature in the United States, the vacuum furnace is still almost exclusively a laboratory tool. Only in rare cases is vacuum annealing being applied on a semi-commercial scale, and vacuum melting is not used at all.

In Europe, however, at least one place is known where commercial vacuum melting furnaces are in continuous use. This is Heraeus-Vacuumschmelze A.G. at Hanau-am-Main, Germany.

According to Dr. Rohn[7] the only satisfactory method of complete elimination of shrinkage cavities and blow holes in high grade metals and alloys is melting and casting them in a sufficiently high vacuum. His paper describes two methods of doing it on a commercial scale.

In the first method a crucible is used of the shape which corresponds to the shape of the ingot to be produced, as shown in Fig. 7, in which A is the crucible, B is the molten metal, C is the heating element of resistance type or an induction coil. "The heating element or the induction coil is provided with tappings as shown on the left of the drawing. Successive sections of the heating element or of the inductor coil can be cut out gradually, starting from the bottom." By using a proper rate of cooling (about 1/8 in. per min.), the shrinkage cavity can be eliminated entirely. If a furnace of this type is small, a movable support on which the crucible is placed may be provided. By lowering the crucible after the melting process is completed, with a suitable rate of speed, the same effect may be secured.

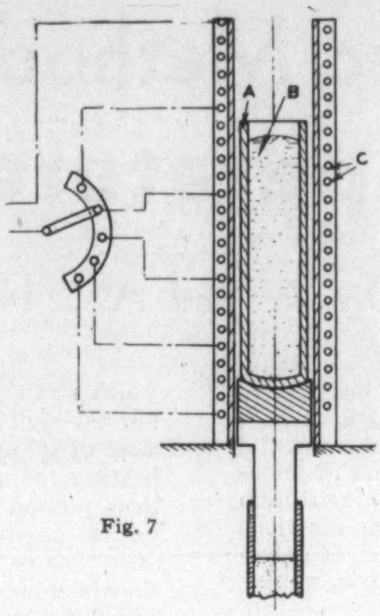

Fig. 7

The other method (Fig. 8) is melting and pouring metals in vacuum into water cooled copper molds. Charges of 4 tons are melted and poured at pressures of 2-5 mm. mercury and a temperature of 1600°-1700°C. If a melt is poured at pressures higher than this, ingots show blow holes caused by gases which are given off during solidification, but if the vacuum is of the magnitude just specified, "the resulting ingots can be sawed into discs 1/2 in. thick," and upon examining them with a lens, "no holes or pores can be found."

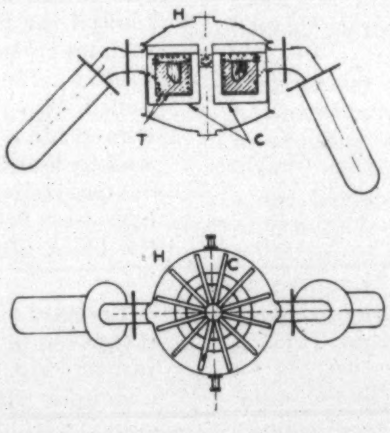

Fig. 8

"The furnace used for this purpose is of the induction type with a horizontal ring-shaped melting bath, as shown in Fig. 8. The iron core is divided into a number of parts, C, so as to obtain a very homogeneous magnetic field, and to avoid every induction effect in the casting. The primary coil consists of water-cooled tubes, T, of electrolytic copper; it is divided into 4 parts, which are placed at the inside and outside and at the top and bottom of the cage formed by the single cores C. The melting bath is therefore surrounded on all sides by water cooled tubes, and the transformer cores are kept cool. If these 4 parts of the primary coil are connected in series, the magnetic field is a very homogeneous one, and a very small stirring effect occurs. During the degasifying reaction, one part of the primary only is fed. This produces a much stronger stirring effect, which facilitates every slag reaction and degasifying process. Two molds are coupled directly with an air-tight connection, to the main casing of the furnace, and a number of windows of fused quartz are provided to allow observation of the progress of the melting and degasifying process and pouring operation. Pouring is carried out by tilting the whole furnace; the second pouring operation cannot be carried out until the ingot first poured has solidified."

In vacuum melting the refractories are of primary importance and constitute a problem difficult to solve. It is obvious that they should be free from all moisture and volatile substances. For this reason, the hearth of the furnace is relined for every new heat with silica, fused alumina, or magnesite, containing necessary additions of auxiliary material, such as powdered glass or boric acid. This composition of the refractory material is selected so that it sinters about 50° below the melting point of the charge, thus forming a strong lining.

Application and development of vacuum melting is justified by the fact that alloys properly prepared in vacuum possess certain properties which cannot be obtained by any other means. For example, 4% silicon iron alloys, prepared in a sufficiently high vacuum, have higher purity and consequently higher magnetic properties than similar alloys melted even in a hydrogen atmosphere. Some alloys, such as 8% aluminum-iron, which are very difficult to make under ordinary conditions, are prepared without any trouble in vacuum. Afterwards they can be forged hot or worked cold down to any desired size and shape. It is known that electrolytic nickel, if melted in air without any deoxidizer, would be too brittle for any practical use. The same electrolytic nickel, melted in vacuum, can be forged to thin rods, and then swedged and drawn to wire. Vacuum melted electrolytic copper does not contain any oxygen, and for this reason is never sensitive to hydrogen embrittlement.

Many other examples of superiority of vacuum prepared, or vacuum treated alloys can be given, but for the present the above will suffice.

Whether or not reduced pressures will ever be extensively used on a commercial scale, is a question of pure economies, i.e., of relative usefulness of alloys of superior quality, because even now large commercial vacuum furnaces could be constructed without much technical difficulty.

The price of a vacuum melted material could be considerably reduced, without sacrificing its quality, if melting could be performed elsewhere, the charge introduced into the vacuum furnace in a molten state, and only the last refinement and casting performed in vacuum.

The following data, given by Rohn, is very suggestive and indicates the growth of production of vacuum melted alloys.[8]

Year	Largest Vacuum Ingot Produced
1917	4 kg.
1920	21 kg.
1924	230 kg.
1926	1400 kg.
1928	2000 kg.

The annual production of vacuum-melted metal has risen from 12 tons in 1924 to nearly 50 tons in 1926, and approached 110 tons in 1928.

In view of an ever growing demand of higher quality alloys, and in view of the willingness of the customers to pay higher prices for a better product, the author is of the opinion that, at present, vacuum furnaces are in a position similar to that in which electric furnaces were 25-30 years ago—just on the edge of ceasing to be laboratory apparatus, and of becoming commercial tools.

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A Metallographic Method for Determining Furnace Temperature Uniformity

by E. H. Dix, Jr.* and A. C. Heath, Jr.**

IN THE Aluminum Research Laboratories it has been found necessary, occasionally, to obtain an accurate idea of temperature gradients existing in furnaces used in experimental work, particularly those used for prolonged annealing of aluminum alloys for alloy equilibrium investigations. A description of the principle and procedure may suggest other applications for a method which has been successfully employed in determining the temperature uniformity in a small, electric, muffle-type furnace.

The principle of Seger cones, which are used for a similar purpose, depends upon the softening of a conglomerate of certain substances such as alumina, feldspar, etc., at a definite temperature determined by the kind and relative proportions of the components. In the present method, however, the fixed point is the melting point of a binary eutectic of aluminum and a second phase; either an intermetallic compound or a pure element. Thus if an alloy of hypoeutectic composition containing for example 30% eutectic is heated to or above the eutectic melting temperature and quenched, a microscopic examination of the alloy will show that part of the eutectic was molten at the time of quenching. Heating at temperatures immediately below the eutectic temperature will of course be without effect.

In annealing specimens of aluminum alloys for solid solubility determinations a small electric muffle-type furnace with automatic temperature control is used. In order to further dampen the temperature fluctuation, a large block of cast aluminum, drilled to receive the specimens for heat treatment, is placed in the furnace. A chromel-alumel thermocouple located near the center of the block gives the temperature existing at this point, which is taken as the nominal annealing temperature. It was therefore necessary to know the actual departure of the temperature in various parts of the annealing block from the temperature indicated by this thermocouple. Small sheet samples, 0.064 inch thick, of a high purity aluminum-silicon alloy containing 6% silicon were placed at different points in the block, which was then heated to temperatures ranging from 5° C. below the aluminum-silicon eutectic melting point to 3° above it; a set of specimens being quenched from each temperature after heating for a period of one hour or more. The samples were then polished and examined microscopically for evidence of partial melting. The metallographic preparation of the specimens was expedited considerably by using them in sheet form, since a number could be bolted together and polished as one. The difference between the known melting point of the eutectic and the observed block temperature at which any specimen exhibited the first signs of partial fusion therefore was the error in temperature between the recorded figure and the specimen location. Since the temperature at all points could be determined with reference to this fixed recorder point, the temperature gradients between all points were then known. It might be well to point out here that, although it is very satisfactory for the determination of small temperature gradients, the procedure has very definite limitations when the variations throughout the block are large.

Eutectic melting in these specimens was quite easily observed under the microscope. Figs. 1 and 2 at 100 and 500 diameters, respectively, show a part of a cross-section of a 6% silicon-aluminum sheet which had been heated at 577°-578° C., the eutectic temperature, for a period of approximately one hour, and quenched. The part of the alloy that was molten at the time of quenching is indicated by the presence of a fine aluminum-silicon eutectic structure forming a more or less continuous network as shown in Fig. 1, and in greater detail in Fig. 2, although even in the latter micrograph the structure is often not completely resolved. In the white matrix of aluminum will also be distinguished dark particles of silicon which belong to the original rolled structure of the sheet and which have coalesced at the relatively high temperature of heating. It is evident that a state of thermal equilibrium was not obtained during the period of heating since, under that condition, at the eutectic temperature the aluminum solid solution would coexist with a liquid of eutectic concentration, and the excess silicon, now visible as larger particles, would be dissolved in the melt.

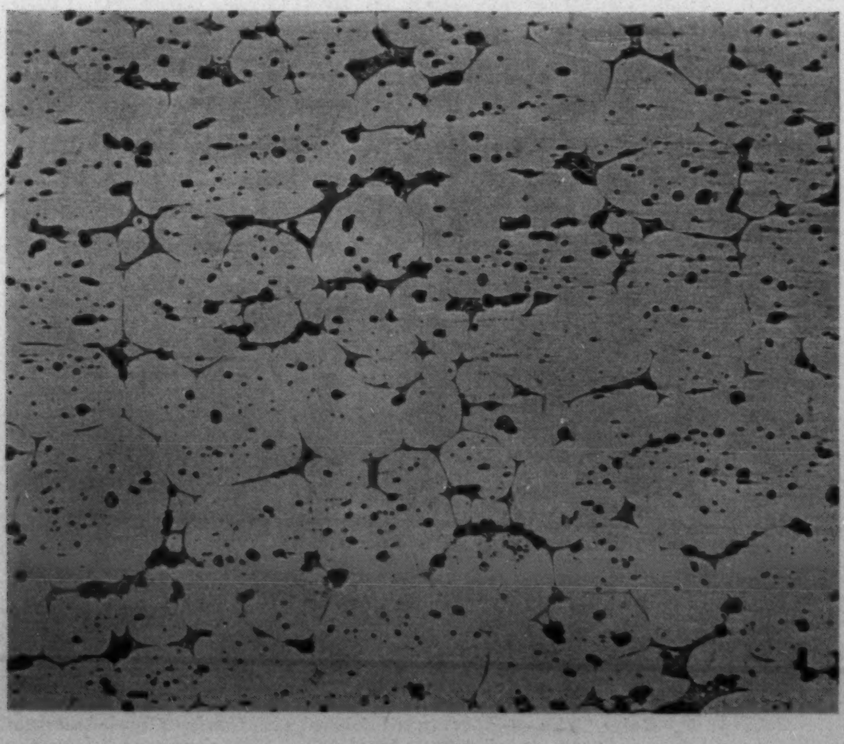

Figure 1. Mag. 100×

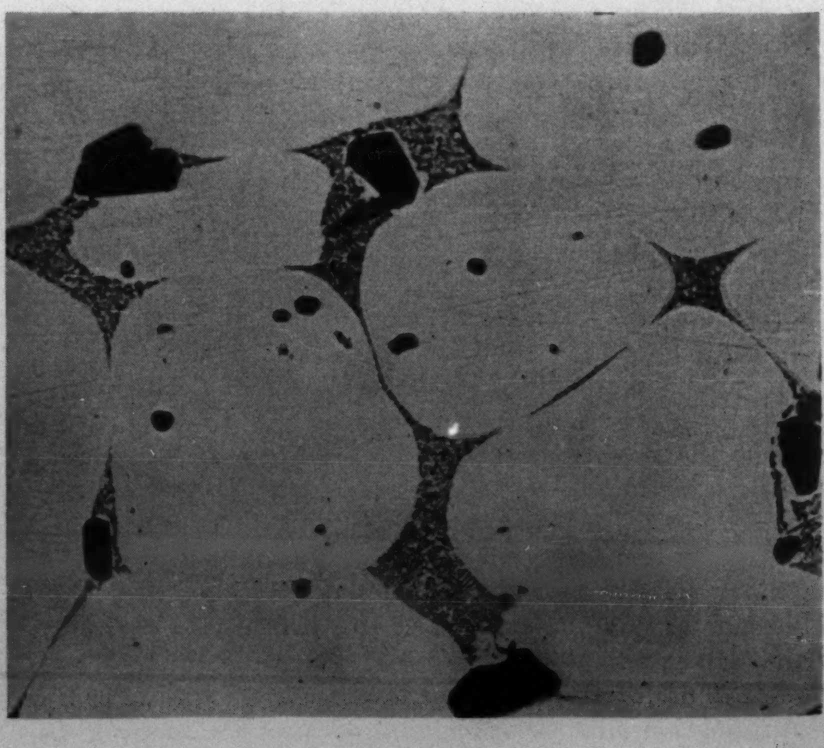

Figure 2. Mag. 500×.

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Corrosion Tests on Weld Deposits

by F. R. Hensel and C. S. Williams[*]

Any accelerated corrosion tests are liable to mis-interpretation when attempts are made to draw conclusions as to life in actual service. Tests in acids which chew up the metal so fast that the metal would never be used as a material of construction in contact with those acids, have often, in the past, been used as sales arguments that the metals would resist atmospheric attack in the same order in which they resist acid attack, though there is no connection at all between the two sets of conditions.

The authors of this paper carefully disclaim any purpose of establishing the corrosion-resistance of welds in service by the tests reported. Instead they are really making, not corrosion tests in the ordinary sense, but a type of deep-etch test to show differences in structure and homogeneity of welds.

The reader's attention is called to the fact that the point of view of the authors is thus that of evaluation of materials from what may be termed the deep-etch point of view and not from the corrosion point of view. The reported corrosion tests are a tool, not an end in themselves.

Introduction

FOR the investigation of the relative corrosion resistance of various types of welds a somewhat modified alternate immersion type of corrosion machine was constructed since this type has given consistent and reproducible results in the hands of others.[†]

Most of the preliminary data presented in this paper were obtained from accelerated corrosion tests made with HCl and NaCl solutions of considerably higher strength than those to which steel structures are usually subjected. No attempt was made to establish a definite realtionship between the corrosive effects of the solutions used and those normally encountered in marine service or other commercial applications. Tests in this direction, however, are under way and will be reported later.

The present investigation was concerned mainly in establishing the relative performance of weld metal produced by 4 different types of electrode rods. Their relative merit was measured by the ability of the deposited weld metal, obtained from each rod, to resist the action of HCl and NaCl solutions. The comparative results should be useful and instructive to anyone interested in selecting a welding wire. The data, however, should not be considered as a means for making predictions of service under other conditions.

Description of Corrosion Testing Machine

The machine was of the alternate immersion type, i. e., a specimen was lowered into a corrosive liquid bath, held there for a period, raised and held exposed to the atmosphere for a period, etc. Several detail changes were made from the apparatus as described by Rawdon, Krynitsky and Finkeldey.[†] The main differences are in two changes or substitutions and one addition.

We used a different means than their system of bell cranks with silk threads and pulleys to insure that there was only vertical motion of the specimen. The clock mechanism for timing was changed. Temperature control for the corrosive liquid containers was added, thus removing one of the variables encountered.

The corrosive liquids were placed in Pyrex beakers of 3 liters capacity set in a controlled temperature water bath in a lead lined box. There were 4 rows of 6 beakers each, as may be seen in Fig. 1. The water bath was maintained at 30° C. ± 0.5° and was heated by 3 standard immersion heaters, one of which was controlled by a De Khotinsky thermoregulator, the other two manually. Circulation of the water bath was maintained by a motor driven propeller. The path of the circulating water was controlled by sheet lead baffles set between the beakers.

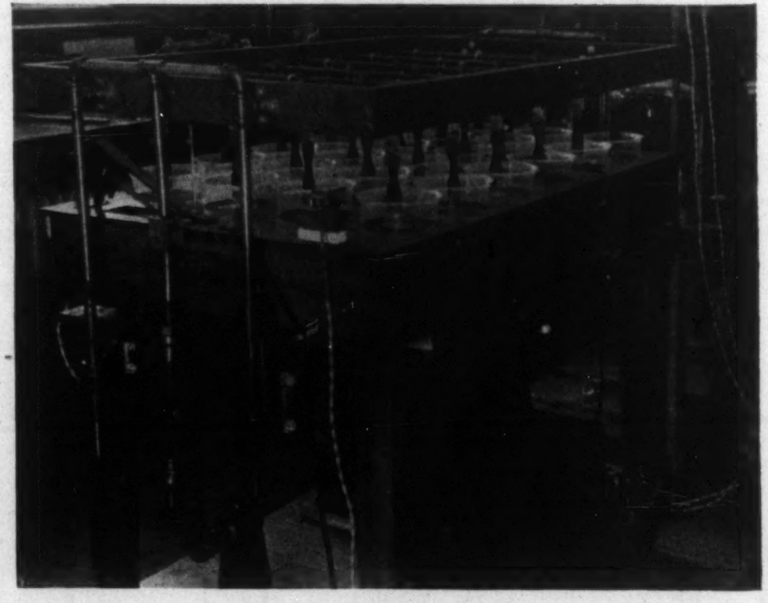

Fig. 1.

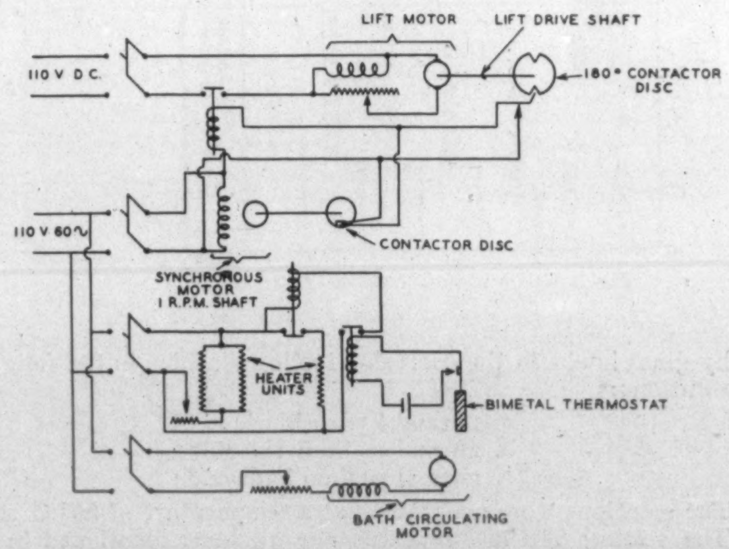

Fig. 2. Electrical Control System of Corrosion Apparatus for Weld Testing

The specimens to be corroded were suspended by glass hooks from a wooden rack which was movable vertically and held in position at each end by 2 bars running in guides. The vertical motion was imparted to the rack by a connecting rod and bell crank at each end, the bell crank shaft being driven by a ¼ H.P. d.c. motor through a worm gear.

The timing unit comprised a 2 watt synchronous motor geared to 2 shafts (1 and 1/30 r.p.m.) which carry contact discs. Contact made on one disc or a combination of the two discs, closes the lift motor relay, thus initiating rotation of the bell crank shaft or lift drive shaft as it is termed on Fig. 2. This moves the 180° contactor disc mounted on the bell crank shaft closing these contacts which keeps the lift motor relay closed until the bell crank shaft has rotated 180°. See

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[*] Westinghouse Research Laboratories, East Pittsburgh, Pa.

[†] Rawdon, Krynitsky & Finkeldey. Types of Apparatus used in testing the corrodibility of metals. *Proceedings American Society for Testing Materials,* Vol. 24, Pt. II, 1924, pages 715-734.

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Fig. 2. The timing disc contacts have opened in the meantime, hence rotation of the bell crank shaft ceases after turning 180°. Adjustment of the position of the 180° contactor disc on the bell crank shaft insures the movement of the rack and specimens suspended from it, from upper to lower position and vice versa in one step and the cessation of motion upon arrival in either position. The reliability of the lift mechanism and timing devices was tested over a period of many months, during which time the rack made each scheduled cycle without failure.

The electrical connections are shown in Fig. 2. The relays for lift motor and heater unit, also the timing unit are enclosed on the shelf beneath the table, as may be seen in Fig. 1. The manual controls for bath heaters, circulating motor and lift motor are beside the relay enclosure.

Calibration of Corrosion Testing Machine

For calibration of the test method, the following standard materials were used:

1. Monel metal
2. Aluminum
3. Nickel
4. Copper
5. Armco iron
6. Izett steel
7. Low carbon open hearth steel
8. Low carbon Bessemer steel

In these tests the weight loss of samples 2″ long x ½″ diameter was determined as a measure of the corrosion. The samples were polished through 00 Barton (French emery) paper. After cleaning in gasoline, alcohol and ether in the order named, they were weighed and suspended by glass hooks in the corrosion testing machine in the following solutions:

a. normal hydrochloric acid
b. normal sodium chloride
c. normal sodium hydroxide

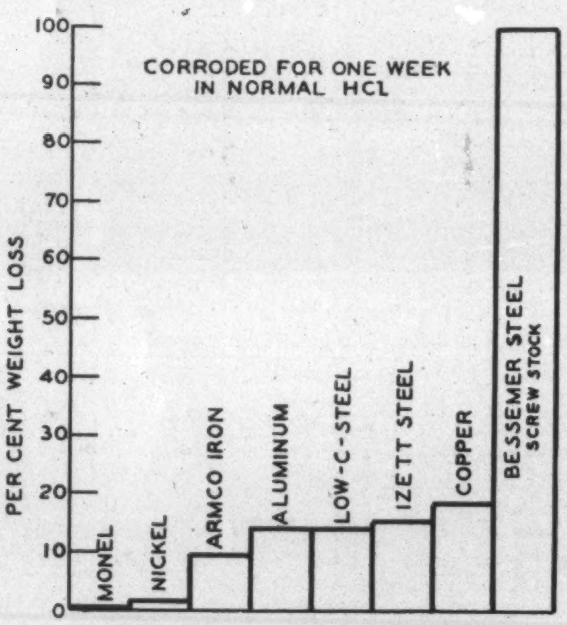

Fig. 3. Calibration Corrosion Tests

The solutions were maintained at a temperature of 30° C. ± 1°. The setting of the apparatus for all tests mentioned in this paper was such as to give a 2 minute cycle, one minute immersed and one minute in air. After a week's run, the samples were removed, cleaned with a stiff brush, dried and weighed. All samples were run in duplicate.

The results showed that the new machine provides reproducible results, which fact is important in corrosion testing. The data on the tests in normal HCl are plotted in Fig. 3.

Testing Procedure and Test Material

The following tests were made:

a. Determination of weight loss with polished samples 2″ long, ½″ diameter.

b. Determination of tensile properties of welded joints after testing.

The tensile specimens as shown by Fig. 4 were designed so that they should normally break in the weld and with such dimensions and proportions that the tensile data obtained should be comparable with standard data on weld specimens. Single vee welds were made on ⅜″ thick low carbon steel plate, and from these were cut the test specimens of Fig. 4.

Table 1. Test Materials

Mark	Description	Type of Test Piece
No. 192	Coated wire "F" 3/16″ dia. 220 A., 30 V. D.C.	Tensile test pieces and cylindrical test pieces.
No. 193	Coated wire "W" 3/16″ dia. 220 A., 30 V. D.C.	Tensile test pieces and cylindrical test pieces.
No. 194	Bare wire "FA" 3/16″ dia. 265 A., 17 V. D.C.	Tensile test pieces and cylindrical test pieces.
No. 195	Dust coated wire "K" 3/16″ dia. 265 A., 17 V. D.C.	Cylindrical test pieces.

c. Macroexamination to study the type of attack (uniform attack, pitting, etc.)

d. Microexamination to study the effect of grain size and difference in composition of weld and parent metal on the attack of the weld and adjacent metal.

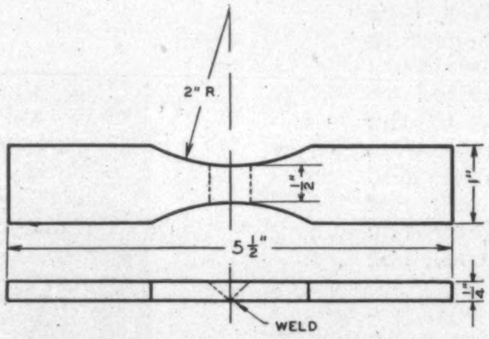

Fig. 4. Corrosion—Tensile Weld Specimen

The test materials used are listed in Table 1.

The corrosive agents used in the preliminary tests reported in this paper were:

a. normal hydrochloric acid
b. normal sodium chloride

The presence of oxygen which is provided in the corrosion machine by lifting the samples into the air is of particular importance for the tests with normal sodium chloride. Here the presence of oxygen increases the velocity of reaction provided the corrosion products do not produce coherent films tending to retard the corrosive attack as in the case of Al, Zn, Cu, etc. In the corrosion of steel and low carbon steel welds, the layers of rust are usually porous and crystalline and do not give much protection against further corrosion.

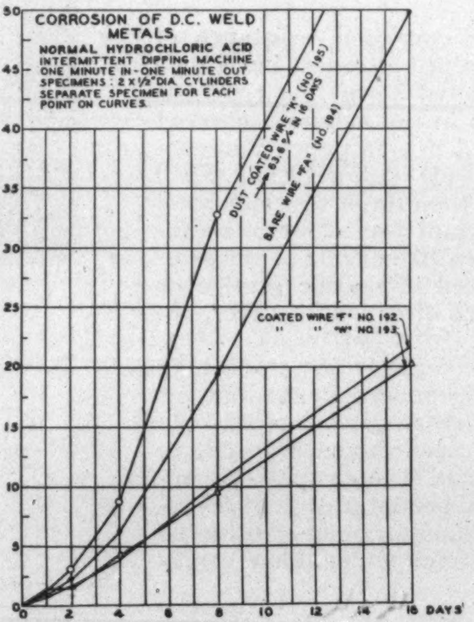

Fig. 5

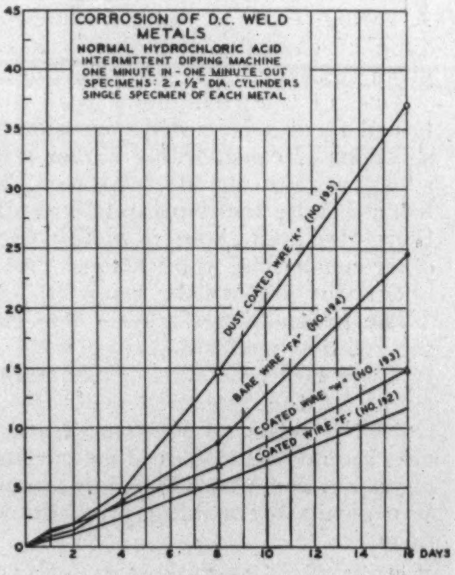

Fig. 6

Any corrosion process can be represented by certain electrochemical equations, an example of which is given here for the case of water ($H_2O \rightleftharpoons H^+ + OH^-$) and iron:

$$Fe \rightarrow Fe^{++} + 2\,e \qquad 2\,H + O = H_2O$$
$$2\,e + 2\,H^+ \rightarrow 2\,H \qquad Fe^{++} + 2\,OH^- \rightarrow Fe\,(OH)_2$$

It is obvious that similar equations can be set up for sodium chloride ($NaCl \rightleftharpoons Na^+ + Cl^-$) or hydrochloric acid ($HCl \rightleftharpoons H^+ + Cl^-$). When corrosion occurs in weak acids, the presence of air usually increases the velocity of the corrosion process slightly. However, in the cases where metals are quickly dissolved in strong acids, the presence of air is of practically no importance.

Test Results

1. Determination of weight loss in normal hydrochloric acid.*

The results are collected in Table 2. Weight loss against corrosion time is plotted in Figs. 5 and 6.

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*These tests were made by Mr. R. H. Wynne of the Chemical Division of Westinghouse Research Laboratories.

In these tests a correction was applied for the loss of acid in the solution because of its dissolving action on iron. The acid concentration was kept at approximately normal by replacing the consumed acid at frequent intervals and bringing the solutions up to their original volume by adding water. The amount of fresh acid was calculated from the weight loss of the corrosion sample. Thus the corrosion went on in a solution containing approximately constant concentration of free acid, but an increasing amount of dissolved iron.

Two sets of tests were made. In the first case, one specimen only was corroded and the points on the curve determined by removing the specimen, weighing it and returning it to the solution for further corrosion. In the second case, a number of specimens were subjected to corrosion. At each desired time a separate sample was removed and weighed. It was found that the weight loss determined by the first method was less than that obtained by the second method of testing. The explanation may be that the surface was rendered somewhat passive in the process of washing and drying.

Table II. Normal HCl Tests of Direct Current Arc Welds

a. Test method: Separate specimen for each test. Specimens 2″ x ½″ diam. cylinders. Weight: 50 ± 1 gr.

Mark	% Weight Loss* 1 day	2 days	4 days	8 days	16 days
#192—Coated Wire "F"	.66	1.67	3.88	10.41	21.64
#193—Coated Wire "W"	1.52	1.55	4.27	9.54	20.13
#194—Bare Wire "FA"	.95	2.24	6.20	19.40	49.75
#195—Dust Coated Wire "K"	1.28	3.15	8.80	32.70	63.91

*Frequently the weight loss is given in mg./cm.^{2}/24 hrs. Due to the rapid change in surface area of the cylinders during testing in normal HCl, it was impossible to define the weight loss by this method. The change in surface area was particularly rapid in bare wire welds. Here the test piece became pitted to such an extent after a few days that its surface area was greatly increased.

b. Test method: One specimen only for each type of weld. Specimens 2″ x ½″ diam. cylinders.

Mark	% Weight Loss 1 day	2 days	4 days	8 days	16 days
#192—Coated Wire "F"	.66	1.12	2.44	5.40	11.65
#193—Coated Wire "W"	1.52	2.02	3.29	6.70	14.82
#194—Bare Wire "FA"	.95	1.51	3.44	8.82	24.46
#195—Dust Coated Wire "K"	1.28	2.00	4.78	14.61	37.11
Comparative sample of standard Mn C steel C = .12 Mn = .34 Si = .01 S = .039 P = .017	.80	1.29	2.66	7.33	20.17

There is a very pronounced difference in the rate of attack on the various types of welds. If we arrange them in the order of the weight loss after 16 days in normal HCl, the following series result:

Type of Weld	% Weight Loss After 16 Days	Comparative Wt. Loss
DC Coated wire "W"	20.13	1
DC Coated wire "F"	21.64	1.04
DC Bare wire "FA"	49.75	2.5
DC Dust coated wire "K"	63.91	3.15

In other words, a deposit made with the dust coated wire "K" was attacked by normal HCl over 3 times as fast as an arc weld deposit made with a high grade coated wire.

By comparing Table 2 with some of the standard tests plotted in Fig. 3, it is evident that the weight loss in normal HCl of a coated wire deposit was about the same as that of Armco iron.

The differences in weight loss might be related to the chemical analysis of the weld deposits. For this purpose, the analytical data are collected in Table 3.

Table III. Chemical Analysis of Various Types of Weld Deposits

Type of Weld	C %	Mn %	Si %	S %	P %	N_2 %	Total Residue %	Structure
DC Coated Wire "W"	.070	.42	.19	.018	.012	.03–.05	.247	Ferrite, some pearlite, some iron nitride "as welded"
DC " Wire "F"	.10	.40	.12	.024	.020	.03–.07	.206	
DC Bare Wire "FA"	.027	.006	.004	.03	.016	.130	.086	Ferrite and iron nitride, some pearlite "as welded"
Dust Coated Wire "K"	.03	.08	.012	.019	.008	.126	—	

The influence of elements other than iron on the rate of corrosion in steel is still a somewhat open question. The condition of these "impurities" is an important factor in corrosion resistance, that is, it makes a difference whether it is present in solid solution in the crystal or present as a separate phase. An "impurity" in solid solution is not likely to favor corrosion. If the impurity is present as a separate phase, its form and state of division are of importance.

Attention is directed here only to the fact that the coated wire weld deposits showed a greater C, Mn, Si and residue content, but an appreciably lower nitrogen content as compared with bare wire welds. Since nitrogen causes age hardening through the precipitation of iron nitrogen compounds in a finely divided state, it is expected to hasten corrosion considerably because of the consequent formation of a large number of local elements.

2. Determination of tensile properties of welded joints after corrosion.

The results of these tests are collected in Tables 4 & 5 and are plotted in Figs. 7 and 8.

The first series of samples was subjected to a normal solution of HCl for 3, 5 and 7 days. The solution height was returned to the starting level each day, the addition being distilled water. No additional acid was added in this case. The time cycle was one minute in the solution and one minute exposed to the air.

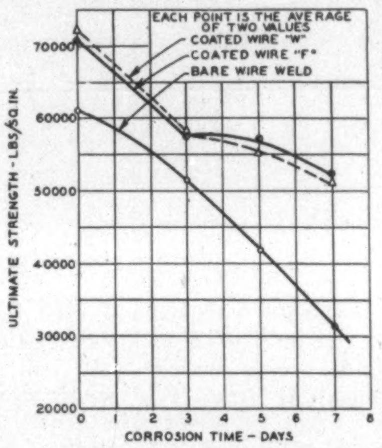

Fig. 7. Effect of Corrosion in Normal HCl Solution on the Ultimate Strength of Low Carbon Steel Vee Type Welded Test Pieces

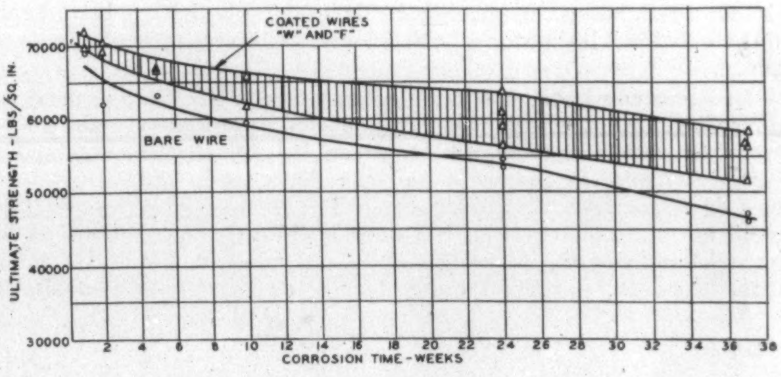

Fig. 8. Effect of Corrosion in Normal NaCl Solution on the Ultimate Strength of Low Carbon Steel Vee Type Welded Test Pieces

The ultimate strengths in Table 4 have been calculated for the original cross-sectional area and also for the cross-sectional area after subjection to normal HCl. The latter values were used for plotting the curve shown in Fig. 7.

Table IV. Effect of Normal HCl on the Tensile Properties of the Welded Test Specimens

Mark	Time of Test Days	Ultimate Strength lbs./in.^{2} based on original area	based on actual area	Remarks
Coated Wire "W"	0	71000 70600	71000 70600	Broke in weld
	3	55200 54500	57500 57600	Broke adjacent to weld
	5	40300 39000	57300 ——	"
	7	29800 28200	50000 54600	"
Coated Wire "F"	0	72600 72000	72600 72000	Broke in weld
	3	54900 52500	57200 57100	Broke adjacent to weld
	5	44200 45300	56000 55000	"
	7	33000 33600	51000 52000	"
Bare Wire "FA"	0	61900 59300	61900 59300	Broke in weld
	3	47200 48800	50000 53000	"
	5	34600 35800	42000 41400	"
	7	24500 25400	31400 ——	"

Table V. Effect of Normal NaCl on the Tensile Properties of Vee Welded Test Specimens

Mark	Time of Test in weeks	Ult. Str. lbs./in.² (orig. area)	Elong. % (½")	Remarks
Coated Wire "W"	1	69000	26	One small gas hole
	2	70600	46	Good weld
	5	66700	52	Good weld
	10	66100	—	Failed in bare metal
	24	56400	20	Gas hole
		59300	44	Good weld
	35	56700	48	Broke in weld
	39	51800	16	Gas hole
Coated Wire "F"	1	72000	22	Gas holes
	2	69700	16	"
	5	66400	32	"
	10	62000	18	"
	24	61000	16	Large gas holes
		64300	20	"
	35	58700	16	Broke in weld
	39	56600	16	Broke in fusion zone
Bare Wire "FA"	1	69100	12	Good weld
	2	62000	14	"
	5	63600	12	"
	10	59600	8	"
	24	53500	6	Broke in weld
		54500	8	"
	35	46000	14	"
	39	47200	10	"

It was found that in the experiments with normal HCl the bare wire "FA" specimens were the only ones to break in the welds, hence the data on the "FA" welds are the only values of weld metal strength. The strength of these "FA" welds rapidly decreased with testing time as may be noted. The decrease in strength of the coated wire welds "W" and "F" could not be determined, since the specimens broke outside the welds and the data obtained indicate only the decrease in strength of the base plate.

In the second series of tensile tests, normal NaCl was used as corrosive agent. Fresh water was added frequently to the solutions to retain the original solution height. In these tests, all samples broke in the weld and the decrease in tensile properties is indicative of the effect of the corrosion action on the weld metal. The attack in the sodium chloride solution was slow as evident already from the standard tests in Table 1. There was, however, a very definite decrease of the tensile strength with corrosion time as may be clearly seen from Fig. 9. The curves for bare wire welds and the coated wire welds are nearly parallel. A somewhat irregular scale and rust was formed on the test pieces during the tests in NaCl. Longer periods of testing will be necessary to evaluate more accurately the effects of various types of weld on the rate of corrosion in salt solutions. Such tests are now in progress.

3. Macroexamination

The appearance of the cylinders after being tested for varied times in normal HCl is shown in Figs. 9 and 10. The tensile test pieces are seen in Figs. 11-14.

The following outstanding facts are revealed by these macrographs:

The bare wire "FA" and dust coated wire "K" show extremely severe pitting. The attack is much more uniform in the coated wire "F" and "W"; only after 16 days in HCl did pitting commence and then only in certain restricted areas.

Fig. 11 shows the type of attack as well as the mode of fracture in the vee type specimens of coated wires "F" and "W" as compared with the bare wire "FA". While the coated wire weld samples broke outside the weld as mentioned before, the bare wire samples broke in the weld. This weakness of the bare wire weld is shown very strikingly in Fig. 13. Although the cross-section of the parent metal after 7 days was considerably smaller than that of the weld, the test sample broke in the weld showing the extreme weakness of the honey combed structure.

Fig. 14 shows the tensile specimens after 5 weeks corrosion in normal NaCl. From a macroscopical point of view, the attack of this salt solution was similar to the attack of normal HCl, insofar as it caused pitting only on the bare wire weld, while the coated wire weld was uniformly attacked.

The striated appearance of the base metal in Figs. 11, 12 and 13 was due to the more rapid attack on impurities which had been elongated in the direction of rolling.

Micro-examination*

The following phenomena were found to exist:

1. It was not unusual to find that pits were most frequent in the parent metal in regions where there were abrupt changes in grain size due to the heat of welding. Fig. 15 shows that attack had started between the normal structure and the refined

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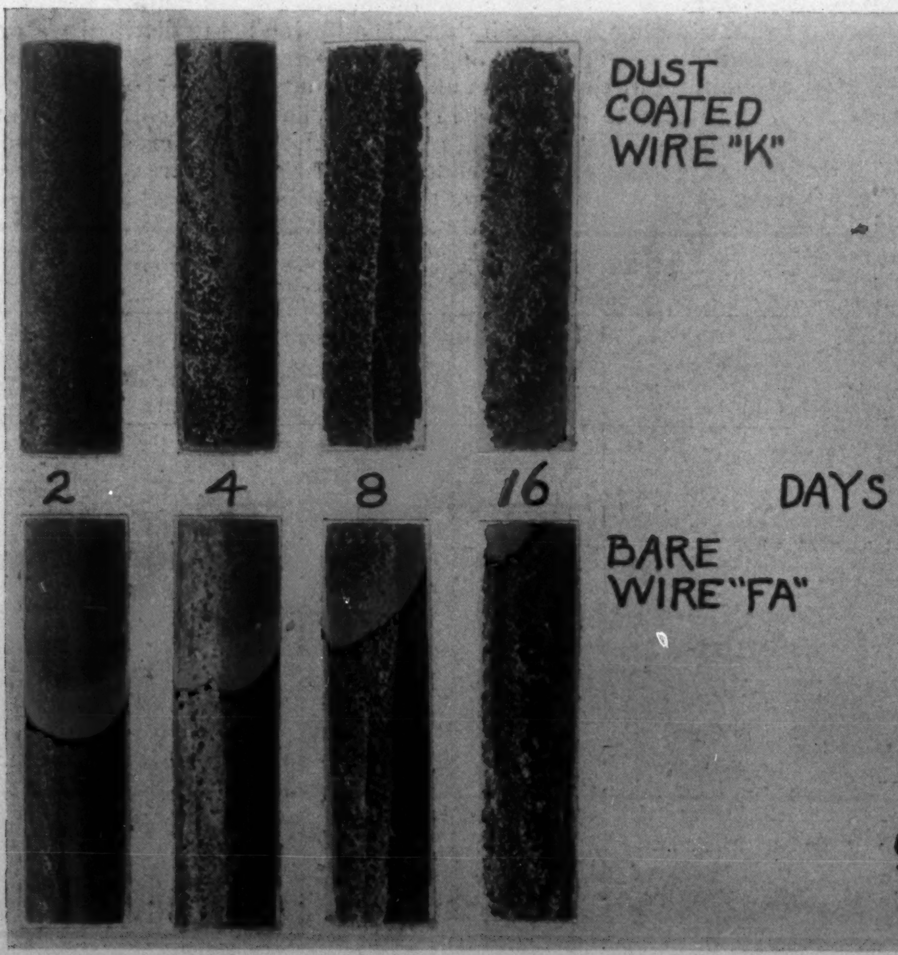
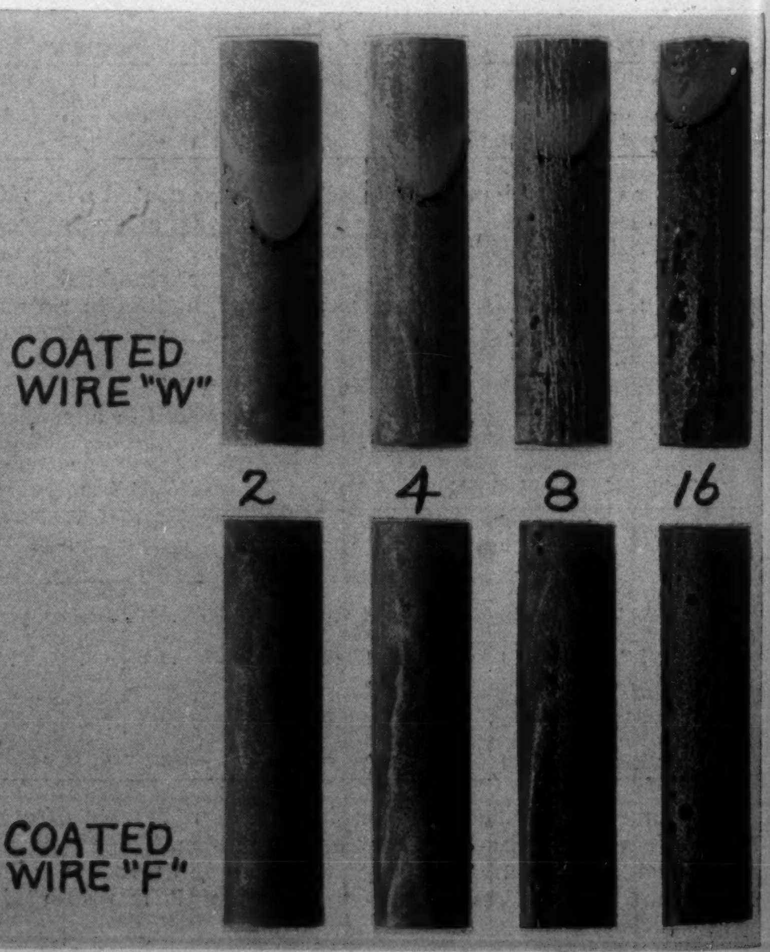
*The microscopical examination was carried out by Miss Mildred Ferguson of the Westinghouse Research Laboratories.

Corroded for Varied Lengths of Time in Normal HCl

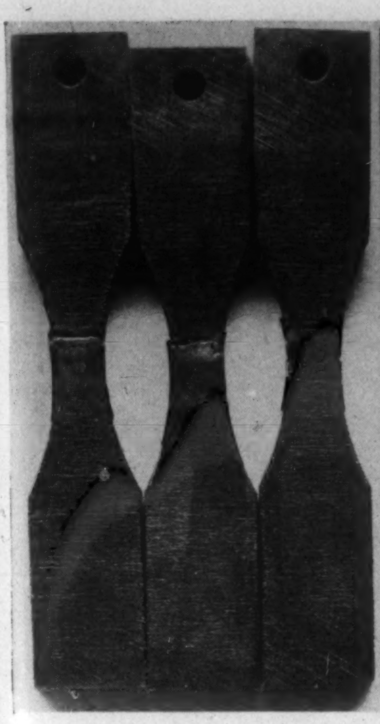


Corroded for Varied Lengths of Time in Normal HCl
Fig. 9

Corroded for Varied Lengths of Time in Normal HCl

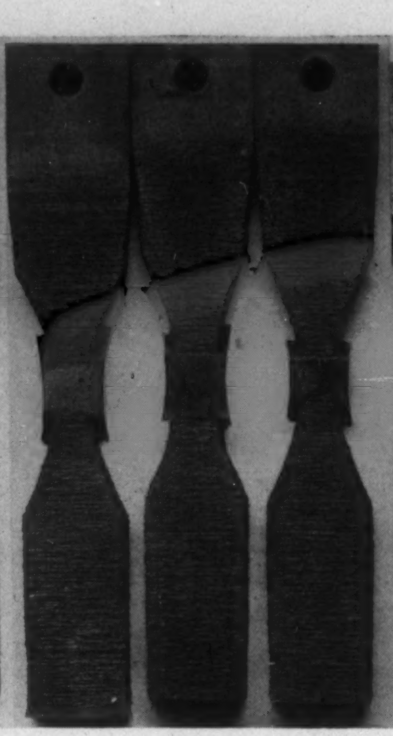


Corroded for Varied Lengths of Time in Normal HCl
Fig. 10



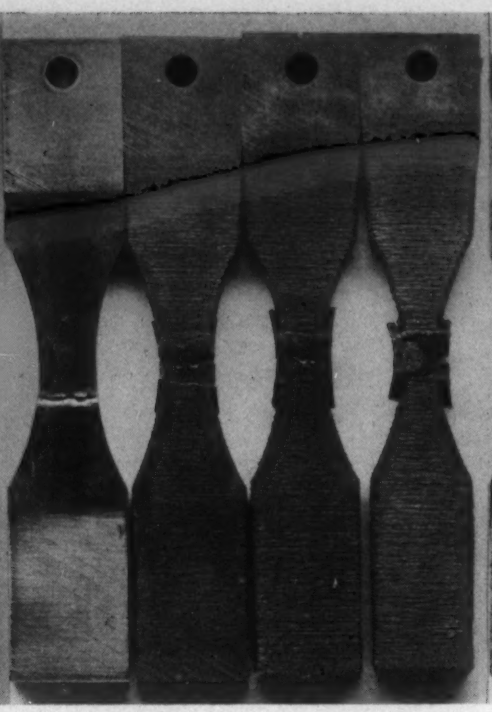
Coated Wire "W" Coated Wire "F" Bare Wire "FA"

After Breaking
Corroded in Normal HCl
Solution 3 Days
Fig. 11



Coated Wire "W" Coated Wire "F" Bare Wire "FA"

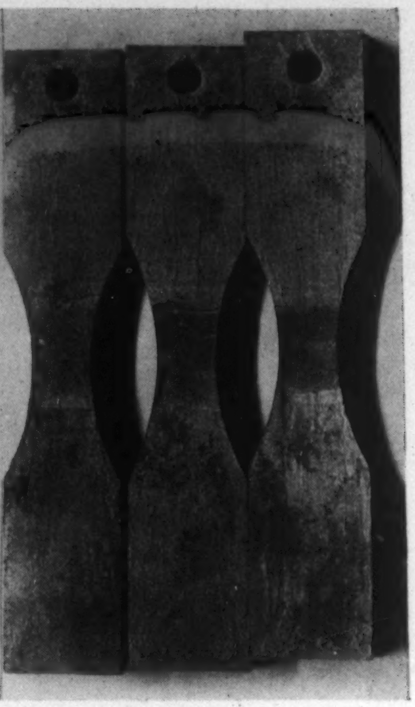
Corroded in Normal HCl
Solution 7 Days
Fig. 12



Not Corroded Bare Wire "FA" 3 Days

Corroded in Normal HCl Solution 5 Days 7 Days

Welds—11 Breaks in Welds
Fig. 13



Coated Wire "W" Coated Wire "F" Bare Wire "FA"

Corroded in Normal NaCl
for 5 Weeks
Fig. 14

zone of the parent metal of vee welds made with coated wire "F" after 7 days in HCl. This condition was found to be particularly marked in those specimens which were in the acid bath.

2. That portion of the parent metal adjacent to the weld which had necessarily been severely heated, apparently stimulated the attack. It appeared that the extent depended on the size of the overheated grains. The phenomenon was observed in samples subjected to HCl and NaCl. (See Figs. 16 and 17.)

3. The effects upon the rate of attack of the crystallographic arrangement and size of grains were pronounced in the different zones of the weld deposits. A zone of small grains, refined by

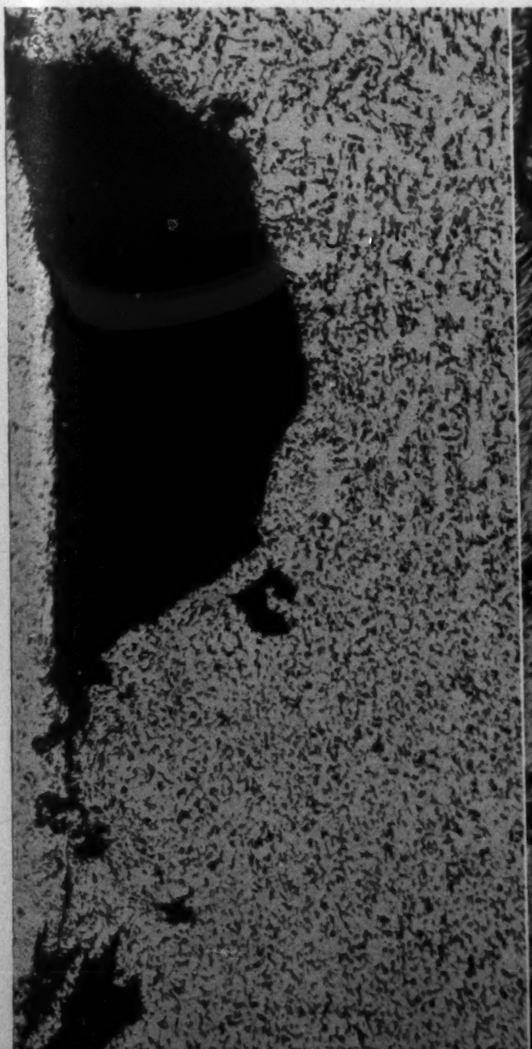


Fig. 15. Magnification 100X. Corrosion at change of grain size in parent metal. Right: Normal Structure. Left: Zone refined by welding. Coated wire "F" after 7 days in HCl.

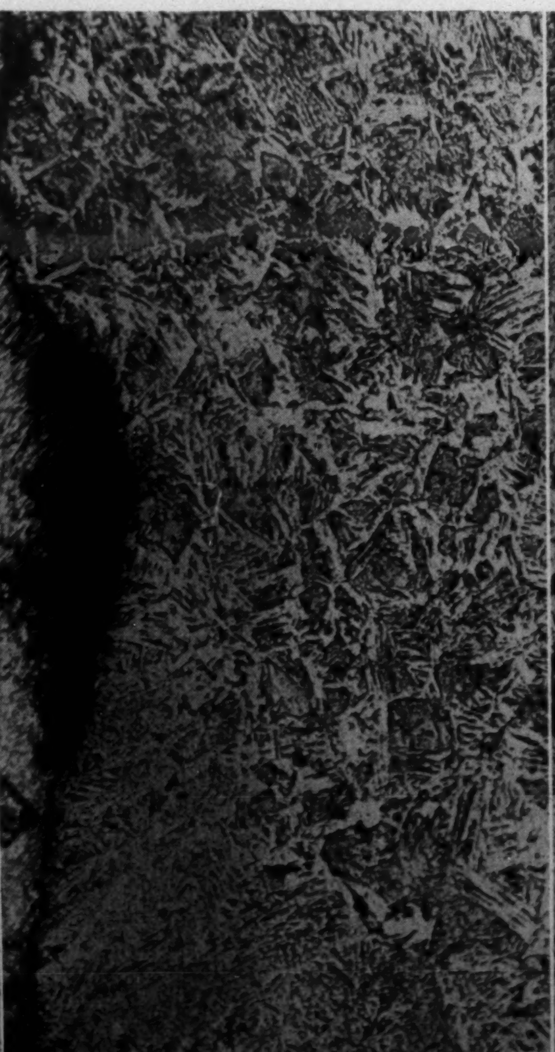


Fig. 16. Magnification 100X. Corrosion between weld metal (upper left) and parent metal which was overheated in welding. Bare wire "FA." After 3 days in HCl

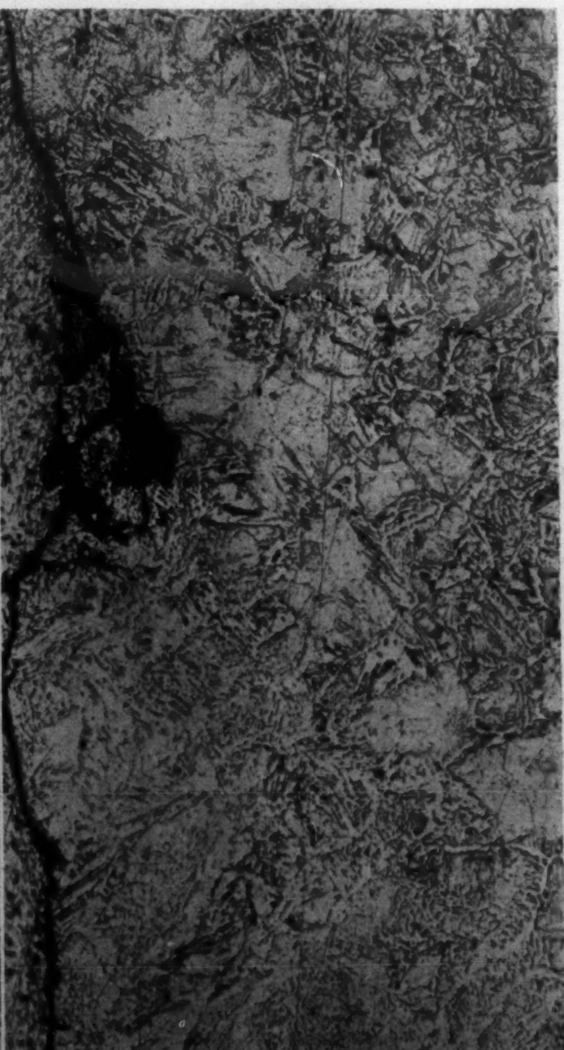


Fig. 17. Magnification 100X. Corrosion between weld metal (upper left) and overheated grains of parent metal. Bare wire "FA" after 23 weeks in NaCl.

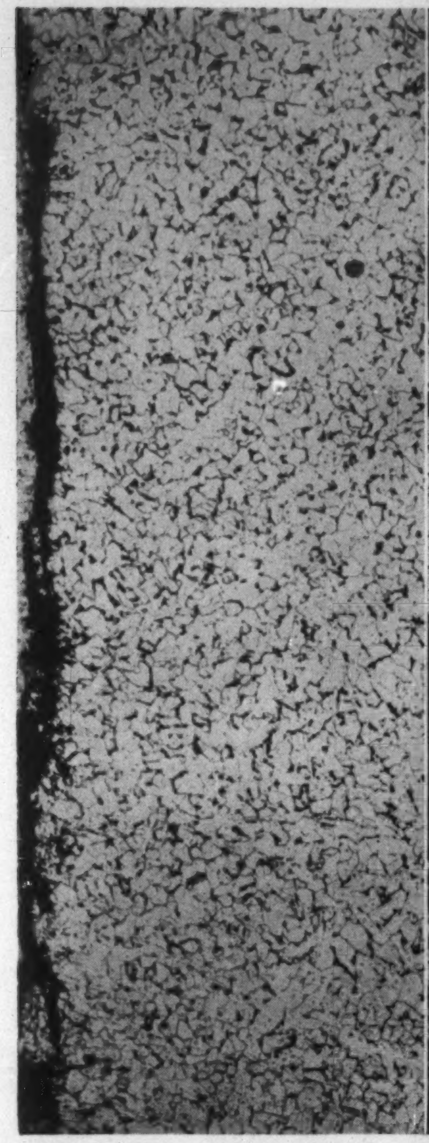


Fig. 18. Magnification 100X. Fine-grained weld metal. Slightly affected by corrosion. Coated wire "W" after 7 days in HCl.

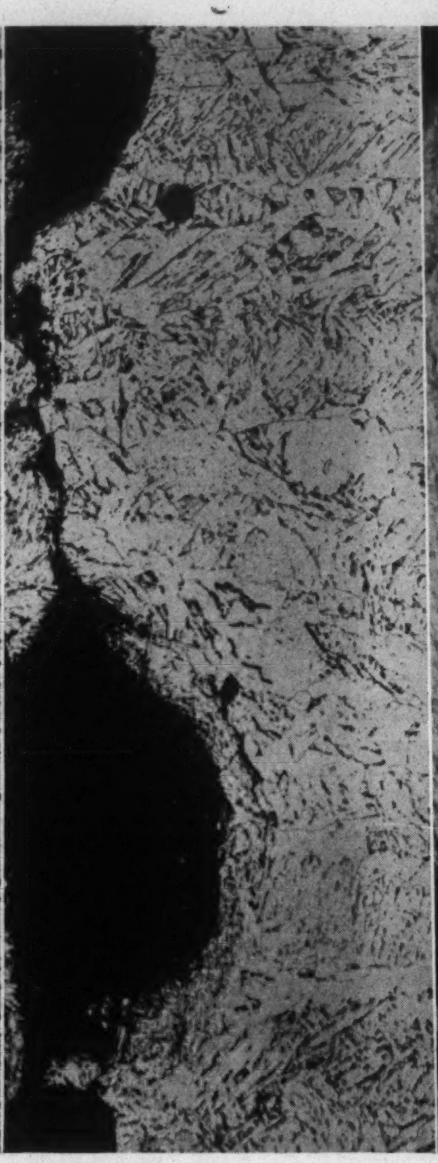


Fig. 19. Magnification 100X. Columnar weld metal. Severely corroded. Coated wire "W" after 7 days in HCl.

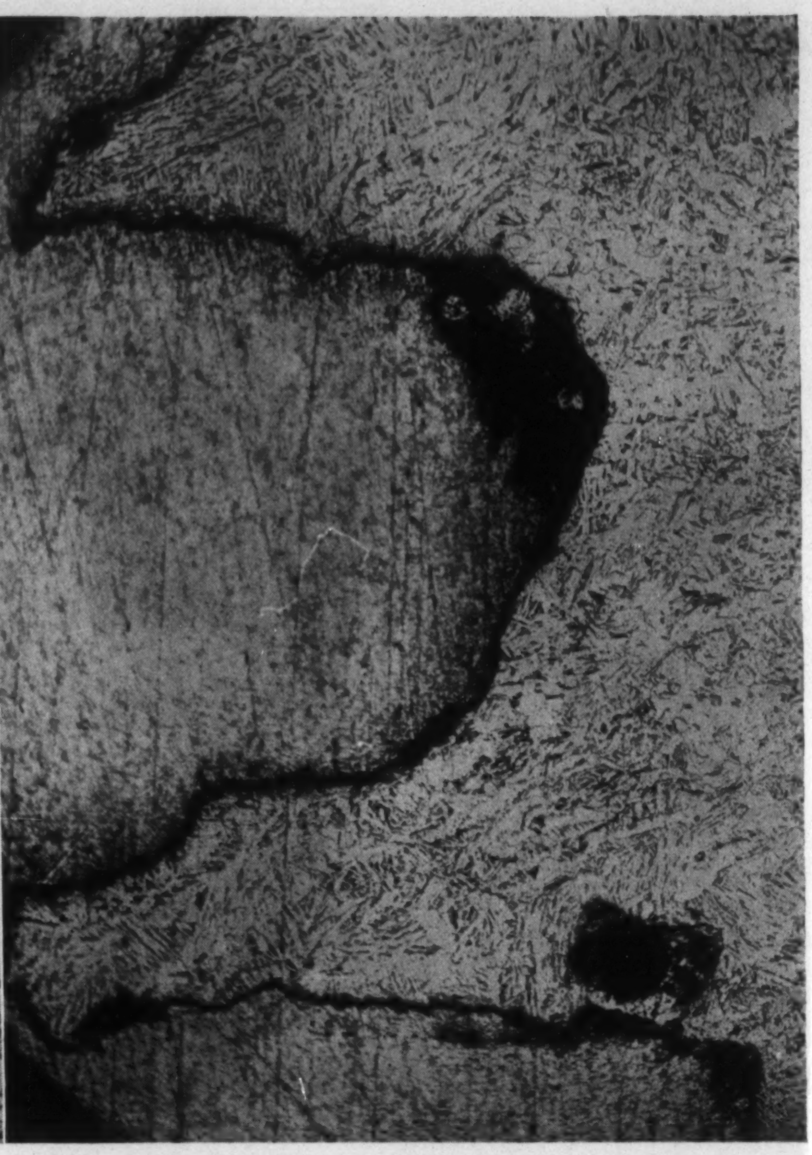


Fig. 20. Magnification 100X. Extreme effects of corrosion in coarse columnar weld metal. Bare wire "FA" after 7 days in HCl. Section through pits.

the heat of the following bead, was much less susceptible to attack than a coarse columnar structure. (See Figs. 18, 19 and 20.) In this respect coated wire welds were superior, since their structure generally was more uniform than that of bare wire welds.

Conclusions

1. A description is given of the mechanical and electrical details of an alternate-immersion type of corrosion test apparatus which was used to determine the relative corrosion resistance of various types of weld metal and welded structures.

2. Preliminary information on standard test materials has shown that reproducible results were obtained in this apparatus.

3. The accelerated tests in normal HCl of samples consisting entirely of weld metal, showed that the rate of attack depended on the methods of welding and the type of weld rod used. An average bare wire was attacked 3 times as fast as a coated wire weld.

4. The effect of corrosion on the tensile properties of arc welded specimens has been studied. While the tensile strength of coated wire welds after subjection to normal HCl was superior to that of the parent metal (low carbon steel), the bare wire welds were attacked so severely that their ultimate strength was found to be much lower than that of the parent metal. The differences in tensile properties between bare and coated wire deposits were less pronounced after corrosion in NaCl.

5. Macrographs show that the attack was partly uniform, partly local, in coated wire arc welds, while bare and dust coated wire deposits were severely pitted and showed relatively little general attack.

6. The microscopical examination showed that the thermal effects of arc welding which cause structural irregularities in the weld metal and the adjacent parent metal such as grain size differences, overheated and columnar structures, are important factors in determining the corrosion resistance of low carbon steel welds.

Acknowledgment

The authors wish to acknowledge their indebtedness to the Westinghouse Electric & Manufacturing Company, in whose Research Laboratories this work was done, for permission to publish the results. Helpful advice and encouragement were given by Mr. P. H. Brace. Messrs. E. B. Ashcraft, R. H. Wynne, C. H. Jennings, E. I. Larsen and Miss Mildred Ferguson deserve much credit for their generous coöperation in this work.

The Sentry Company has moved from Taunton into their new plant at 62 Main Street, Foxboro, Mass.

New Udylite Cleveland Office

In order to facilitate service to the many Udylite customers in an area, the logical center of which is Cleveland, the **Udylite Process Co.** announces the opening of a branch sales and service in 708 Keith Bldg., Cleveland, Ohio. J. S. Hoffman will be in charge of the new branch and will have as his assistants L. J. George, Udylite Service, and C. L. Anger, Supply Division. All of these men are widely known in plating circles and, with the exception of Mr. Anger, have been with Udylite for a number of years. Complete stocks of Udylite materials and supplies will be maintained in Cleveland for the convenience of Udylite licensees.

The Cooley Electric Furnace Company, Long Island City, N. Y., announces the appointment of **Mr. R. A. Schoenfeld** as their representative with offices at 81 West Van Buren Street, Chicago, Ill.

Ryerson Buys Bacon & Company

Joseph T. Ryerson & Son, Inc. of Boston, New York and Chicago has purchased the stock and good will of Bacon & Company, iron and steel company of Boston. Bacon & Company was organized in 1868 by Josiah E. Bacon. The original company was located on Fulton Street in Boston. In 1869 the firm of Bacon & Brown was formed and about '73 moved from Fulton Street to Purchase Street and continued at this address until 1878. Mr. Bacon then retired from the firm of Bacon & Brown and formed Bacon & Company at 127 Oliver Street. Early in 1881 he built his new plant now located at 107-119 Oliver Street.

Impact Resistance of CAST IRON at Elevated Temperature

by F. B. Dahle*

IN a previous publication[1] the mechanical and creep properties of molybdenum cast iron at 700° F. were reported. That publication also reviewed the literature on molybdenum cast irons available at that date.

In continuing the study of the creep properties of molybdenum iron at a higher temperature of 850° F. some unexpected failures due to shock in tension were observed, which suggested a brief study of the tensile impact resistance of cast irons at elevated temperatures.

In loading a specimen of molybdenum cast iron (No. 99, Table I) at 850° F. at a stress of 35,000 lbs./in.^{2}, the specimen fractured suddenly, causing the beam of the creep-testing equipment to drop about an inch, which produced some shock on specimens in adjacent testing units and caused them to fracture. The stresses on specimens of cast iron No. 99 in adjacent units were 28,500 and 45,500 lbs./in.^{2} By reference to Table II it will be noted that a tensile stress of 35,000 lbs./in.^{2} represented a stress of about 67% of the ultimate room-temperature strength of cast iron No. 99.

Considering that the higher load of 45,500 lbs./in.^{2}, or 87.5% of the ultimate strength on a similar specimen had been running for 24 hours without failure, it was not expected that a specimen loaded at the lower stress of 35,000 lbs./in.^{2} would break immediately. This raised a question as to brittleness of such materials at such temperatures.

Tensile-impact tests were therefore made on this molybdenum cast iron and on a plain-carbon cast iron (No. 108, Table I) over the range of temperatures from 700° to 1000° F. For comparison purposes Charpy impact tests on round unnotched bars were also made over the same range of temperature. The compositions of these irons and the properties at room temperature are given in Tables I and II respectively.

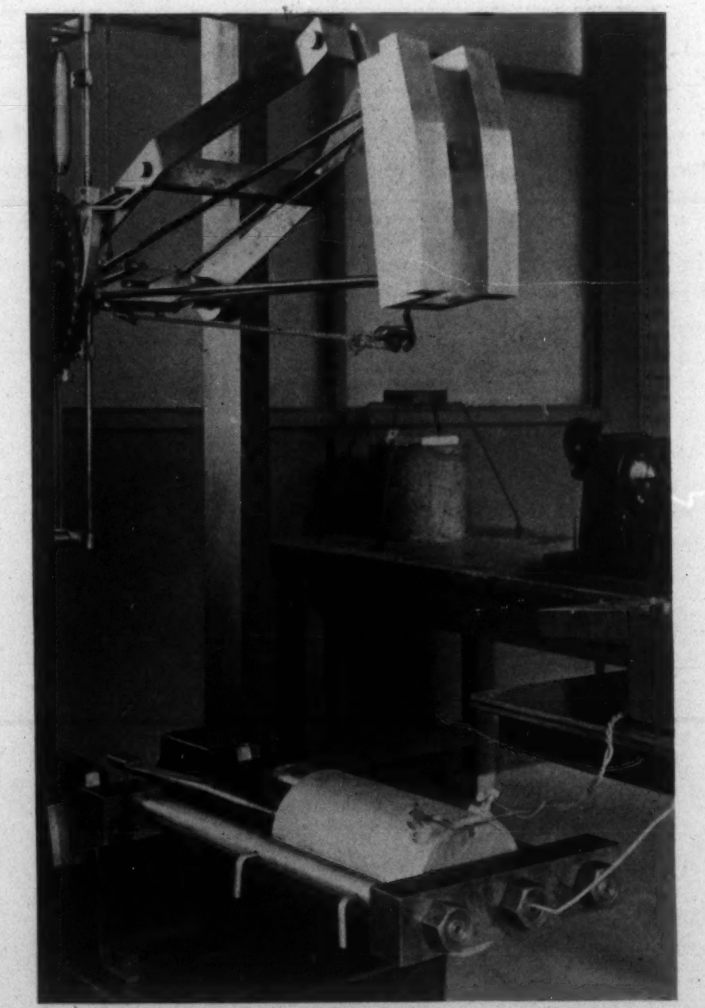


Fig. 1. Tensile Impact Testing Equipment

Experimental Procedure. Since the tensile impact equipment on the Amsler impact machine is designed primarily for room temperature testing, it was necessary to design additional equipment to make the tests at elevated temperatures. Fig. 1 shows the set-up used for the high-temperature tensile-impact testing. It consists essentially of the electric furnace supported by the steel arms leading from the anvil to the back cross-bar. The front adapter attached to the specimen is designed to engage the tup of the Izod hammer at the bottom of the swing. The back adapter is bolted to the cross-bar, which resists the impact blow. The front adapter was calibrated to determine the energy required in overcoming its inertia. The average value obtained in the calibration was deducted from the energy obtained in a test to determine the energy consumed in breaking the specimen.

The high-temperature tensile-impact tests were made on specimens 5-in. long, and were machined with a short-reduced section having a radius of 3/8 in. and a diameter of 0.505 in., as shown in Fig. 2. The 0.505-in. diameter was chosen after previous tests had indicated that smaller sections did not give values sufficiently large to be discriminative. The Charpy impact tests (unnotched) at elevated temperatures were also made on round sections 0.505 in. in diameter so as to have the same section in the 2 tests.

Table I. Chemical Composition of Irons Tested

Heat No.	Element							
	T.C.	C.C.	G.C.	Si	Mn	P	S	Mo
99	2.63	0.96	1.67	1.75	0.63	0.051	0.090	0.82
108	2.81	0.70	2.11	1.69	0.86	0.073	0.028	...

Table II. Room Temperature Properties of Irons Tested

Heat No.	Brinell Hardness	Transverse Strength* lbs.	Tensile Strength lbs./in.^{2}	Tensile Impact ft.-lb.	Charpy Unnotched Impact** ft.-lb.
99	270	6,100	52,000	18.2	4.50
108	234	4,000	42,600	14.2	3.75

*12" span – 1.25" diameter bars.
**Tests made on 0.505" diameter bars.

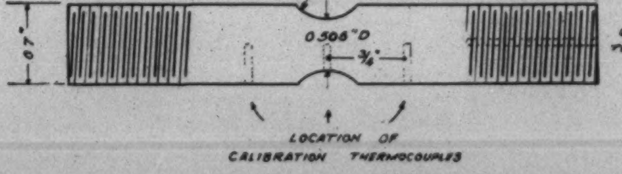


Fig. 2. Test Specimen Used in Tensile Impact Tests

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*Battelle Memorial Institute.

[1] C. H. Lorig & F. B. Dahle. Mechanical and Creep Properties of Molybdenum Cast Iron. *Metals & Alloys,* Vol. 2, Oct. 1931, pages 229-235.

Table III. Impact Test Data

Heat No.	Foot Pounds Energy — Room Temperature		Temperature of Test—Degrees Fahrenheit — 700		800		900		1000	
	Charpy Unnotched	Tensile Impact	Charpy Unnotched	Tensile Impact	Charpy Unnotched	Tensile Impact	Charpy Unnotched	Tensile Impact	Charpy Unnotched	Tensile Impact
108	3.6	13.8	3.2	9.7	3.6	10.3	3.3	10.9	2.6	9.8
	3.9	14.6	3.4	10.3	3.5	10.4	3.2	10.3	3.0	11.4
Average	3.7	14.2	3.3	10.0	3.5	10.3	3.2	10.6	2.8	10.6
99	5.0	17.6	5.0	14.7	4.6	13.9	3.0	12.9	2.8	12.3
	4.1	18.8	5.4	14.4	5.5	14.0	4.8	12.8	3.2	11.3
Average	4.5	18.2	5.2	14.5	5.0	13.9	3.9	12.8	3.0	11.8

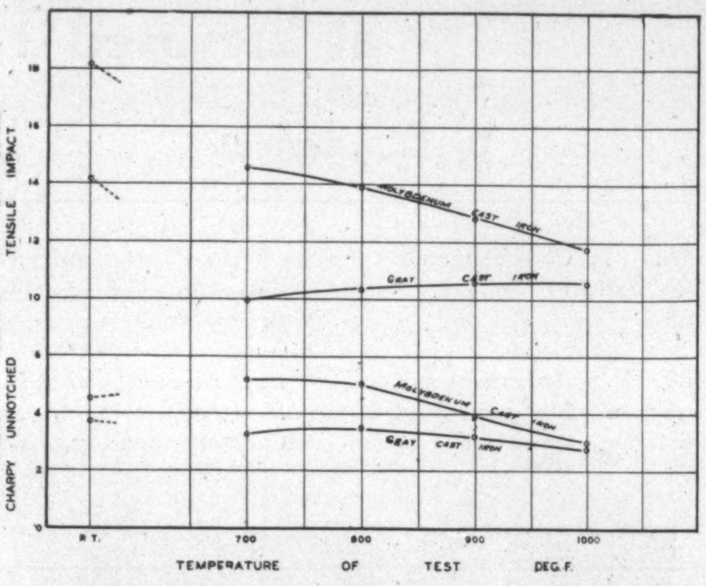


Fig. 3. Effect of Temperature on Impact Resistance of Molybdenum Gray Cast Irons

Before proceeding with the tensile-impact tests a temperature exploration of the furnace was made, using a dummy specimen. Thermocouples were located along the center section of the specimen and in a hole drilled axially in the end, as shown in Fig. 2. The thermocouple placed in the axial hole was used during each test to obtain the proper temperatures. In proceeding with the test the specimen was brought up to temperature and held for 30 minutes before it was broken. For the Charpy impact tests the specimens were heated in a salt bath. After reaching the required temperature they were placed on the anvil and broken within 5 seconds after removing them from the bath. Two specimens of each iron were broken at each temperature. The data from the tensile-impact and Charpy tests are shown in Fig. 3 and Table III.

The data in Table III indicate that duplicate tests agreed fairly well. The trends of the curves in both types of tests are quite similar. This feature shows the general tendency of the tensile impact tests to follow the values obtained in the better known Charpy tests. For the size and shape of the specimens used, the curves also show that the tensile-impact test has a slightly greater degree of selectivity in determining the relative impact strengths of the 2 cast irons. From experience it has been found that the standard notched Charpy test has practically no selectivity on a standard impact machine. This was again demonstrated on 0.8 in. square notched specimens of these irons.

Table IV. Comparison of Results on Room Temperature Tests on Cast Irons

Iron	Chemical Composition					Tensile Strength lb./sq. in.	Impact—Ft.-Lb.	
	T.C.	C.C.	Si	Mn	Mo		Charpy Unnotched Specimen	Tensile Impact 0.505" Diam. Specimen
Heat #108	2.81	0.70	1.69	0.86	......	42,600	3.75 R**	14.2
Q*	2.88	0.63	1.99	0.51	......	40,900	4.10 S***	11.7
Heat #99	2.63	0.96	1.75	0.63	0.82	52,000	4.50 R**	18.2
L*	3.05	0.85	2.70	0.79	0.45	39,200	3.10 S***	11.5

*Committee irons.
**Round specimen, 0.505" diam.
***Square specimen, 0.394"x0.394" (10x10 mm.)

Many data have been collected on the properties of cast iron by a Joint Advisory Committee of the American Foundrymen's Association and the American Society for Testing Materials. Among these data were room temperature impact results on cast irons of various compositions, which were included in the full data distributed to members of the Committee. Some of these data at least will be published in the condensed Committee report when it appears.

In order to make a comparison of the properties of the cast irons used in this study, 2 samples of approximately the same composition were selected from those reported by the Joint Advisory Committee. Table IV shows results obtained in the 2 separate sets of data.

It will be observed that the ordinary gray cast irons whose compositions are similar show good agreement in the impact tests. The molybdenum cast irons differ considerably in composition. The relative impact strengths are, however, in line with the compositions and tensile strengths of the 2 cast irons.

Conclusions. The tests indicate some superiority of the molybdenum cast irons over ordinary gray iron in impact resistance. Molybdenum cast iron retains its superiority, in the types of test made, up to 800° F. and then drops off at the higher temperatures. It may be concluded that molybdenum cast iron will be less likely to fracture from tensile shock than ordinary gray cast iron and that this tendency will exist up to at least 800° F. At 1000° F. the data available indicate that this superiority of the molybdenum cast iron tends to disappear.

At no temperature studied was the shock resistance of the cast irons markedly improved over the room temperature values; so cast iron has to be considered as a relatively brittle material even at elevated temperatures.

Foundry at Battelle Memorial Institute

Letters to the Editor

Statistical Methods

Editor, Metals & Alloys:

I have read the very interesting and very fair editorial discussion on statistical methods in the November issue of Metals & Alloys. You stated that you would like to see a paper written by a lowbrow, so I am enclosing a reprint of mine which completely meets this particular at least.

Robert F. Ferguson

November 28, 1933
Technical Products Company,
Pittsburgh, Pa.,

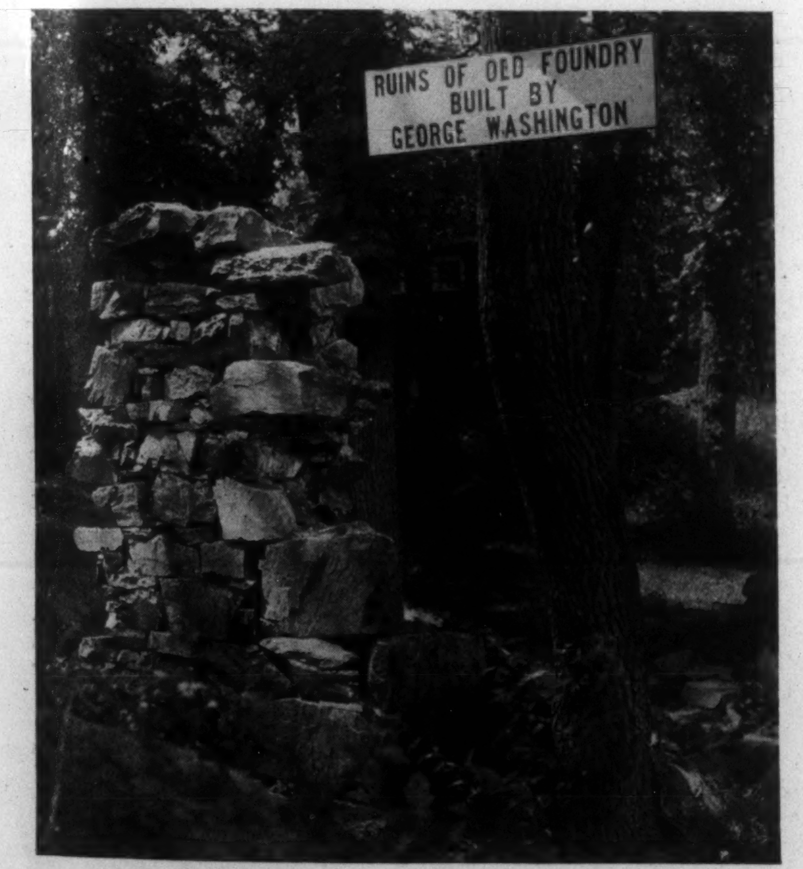
Editorial Note:

This article—"The Interpretation of Plant and Laboratory Test Data" *Journal American Ceramic Society,* Vol. 13, May 1930, pages 359-362, is a clear description of statistical methods from a practical point of view. The examples are drawn from ceramics but are equally applicable to metallurgy. It is recommended to those seeking practical, usable information on the subject.—H. W. Gillett

George Washington Foundryman

Editor, Metals & Alloys:

The enclosed snapshot—with convenient legend showing in the foreground will doubtless find a place in your files where it will be of use to some future historian who wishes to complete the annals of early American metallurgy.



The foundry is situated on the Potomac River at Great Falls, Fairfax County, Virginia. Nearby is a canal built by the Patowmack Company, incorporated for the purpose, of which George Washington was first president.

Frederick Sillers, Jr.

Nov. 23, 1933
Washington, D. C.

Technical German

An advanced sight reading course in technical German is being given by **Richard Rimbach**, Editor of *Metals & Alloys,* at Columbia University, Mines Building, Room 408, on Tuesdays at 8:00 p. m., for men who have had some German. There is no charge for the course. Columbia University will give no credit for this course. Readers of *Metals & Alloys* are invited.

Forever Steel

Editor, Metals & Alloys:

You are not in the habit, I know, of publishing verse in your instructive journal. Nevertheless I am offering you the following bit of symbolism:

FOREVER STEEL

A bar of steel may pass through rolls
And hot or cold will lose its form,
Acquire machine made shapes that take
Their measure from the impress warm.

How different then the steel appears—
Gone is the roughness, gone the scale;
Against the change wrought by the rolls
No shape or structure could prevail.

But length may grow and surface change,
The bar of steel may seem to be
In color, form and temper, then,
A new, a transformed entity.

This is not so!
For steel is steel!
No human agent can transmute
Its heart, its soul, its nature deep
Into some other substance cheap!
And though you think it's not the same—
It is!

We felt the hammers and the rolls,
The grinding clash of steel on steel,
The shock of outlines formed anew,
All these, within ourselves, we feel.

Our temper may have changed, perhaps,
The rolls have made our lines less clear,
We do not seem to be the steel
That once was held so very dear.

How dull, they say, this new one seems,
How lifeless, how devoid of soul!
Once more the ever-turning rolls
Achieve their own apparent goal!

But this I know:
Still are we steel!
No matter how our surface seems
It has no bearing on our heart;
This has not changed the smallest part.
And though they shout, we're not the same,
WE ARE!

Nov. 5, 1933
Newark, N. J.

Fred P. Peters

The Problem of Short-Cuts and Extrapolations in Determining Load-Carrying Ability of Metals at High Temperatures. Shall It Be Attacked?

The Joint Research Committee on Effect of Temperature on the Properties of Metals, the agency set up by the A.S.T.M. and A.S.M.E. to deal with the field denoted by its name, discussed at its last meeting a problem that is looming large in the eyes of engineers who design, who test, and who use alloys at high temperatures.

The logical base line for high temperature design, comparable to the tension test for ordinary temperature design, and like it subject to varying factors of safety dependent on the particular type of service, is the stress for a given amount of deformation, determined by tests, each at one constant temperature and one constant load. This requires a family of curves obtained by long-time "creep" tests.

As is usual in the development of a new type of testing, early results were shrouded in uncertainty because it was not clear whether the discrepancies and discordances in the results of different observers were due to inaccuracies in the method of test, such as insufficient realization of the necessity for precise temperature control, too short periods of test, etc., or to real differences in supposedly similar lots of material. The testing difficulties appear well on the way toward being smoothed out by the promulgation last June of a Tentative Creep Test Code which summarizes in a few essentials of procedure the experience of the Committee members and of those of its many sub-committees. It appears that results of different observers, all adhering to the code, will hereafter show vastly better agreement than some of the older data did, and that the way is thus paved for true appraisal of the actual differences among materials and, in the case of a single material, of the determination of its load-carrying properties. Determination of the spread in load-carrying ability between different lots of material of the same class, so that the designer can intelligently fix "safe loads"—for which the user is clamoring—must await the accumulation of data on lots of known history.

In most cases design cannot wait for this accumulation, so the designer has to make the best guess he can. He knows that the short-time high temperature tensile test by itself gives high values, which, if they have any real value at all in design for structures to be subjected to long loading, must certainly be modified by large factors of safety which must increase, as the temperature is increased, and increase to such large magnitudes that the shakiness of the assumptions made becomes self evident. The designer feels more security in having creep values, from say 1000 hr. tests, as a basis for extrapolation to the years of actual service he desires, but at best he must still extrapolate and must, while lacking actual data, make assumptions as to the conformity of the behavior of the material he uses with available data for behavior of other material of that type that has been previously tested.

Pressure is therefore put on the testing engineer to provide quicker returns when a given lot of material is submitted for high-temperature appraisal. The suggestions for short-cuts have been many. They range from the super-refined determination of short-time proportional limit, through deformation measurements carried on for a day or so, "relaxation" tests starting at high loads automatically reduced, other tests starting at a high temperature with temperature automatically reduced, through cantilever tests, restrained bend tests, step-up and step-down tests on a single specimen, etc., down to the abandonment of all short cuts and the use of the recognized creep method with the aim of carrying it on only for just the period required to show clearly the future behavior of the material. Lack of knowledge as to when the test really becomes sufficient makes this aim difficult of fulfillment, especially since the question of metallurgical stability arises, so that another angle of the problem is how to "incite" metallurgical break-down or stabilization, as the case may be, by shortened methods.

Proponents of suggestions for short-cuts normally advocate them primarily for "sighting shots" to reduce the necessary number of creep tests, or for appraisal of the uniformity of a given material from lot to lot rather than as a true foundation for design values, but either the proposer of the short-cut or someone who reads or hears of it, ultimately attempts to find some conversion formula by which the short test can be made to tell the long story.

Either some such conversion is possible, or none is. Enthusiasm may lead to adoption of an untrue conversion and resulting disaster on the one hand or wasteful use of metal on the other. Conservatism may lead either to excessive cost of testing by sticking to the old ways or to parsimonious failure to make tests where tests are vitally needed, preferring to take chances than to spend money. Progressive engineers have an open-minded attitude toward accelerated methods but at the same time one that demands engineering proof of, instead of mere hope of, correlation.

The Joint Committee has, in its ten years of existence, assembled and disseminated much basic information on the relation between high temperature fatigue and creep, the effect of grain size, etc., and on the broad problem of stability of alloys at high temperature, a metallurgical aspect that must always be considered, and has on its immediate program or those of special sub-committees constituted for the purpose of planning, financing and carrying them out, specific problems on specific alloys whose clarification will advance fundamental knowledge.

A similar Joint Committee recently formed in England for study of high temperature problems is reported by the British Engineering press as in progress of financing, jointly by industry and the government, and on quite an extensive scale, a three-year research program. British editorial comment refers to support of the program as a patriotic duty for the maintenance of British progress against the advances resulting from high temperature research in other countries. The broadest task of such Joint Committees is to develop acceptable methods for evaluation of high temperature properties which industry may use to get the specific data required on specific alloys as new alloys are suggested for high temperature service, or to appraise the uniformity from lot to lot of older alloys.

The British editorial comment referred to is found on pages 603-604 of the December 1 issue of *Engineering* (London), and on pages 542-543, 549 and 554 of the *Engineer* (London).

The correlation of long duration, research type test methods and rapid shop or acceptance test methods was one of the original purposes for which the American Joint Committee was formed and which has had constant consideration in its councils. Until recently, the creep determination itself was hardly on a firm enough foundation to serve as a useful base line for the comparison. Today it seems, while still subject to improvement and still calling for experience and engineering judgment in its application, to be usable as such a base line.

The Committee is therefore suggesting that a correlation program should be undertaken wherein, as a minimum, one ferritic and one austenitic steel, each most carefully chosen for metallurgical uniformity and stability, would be subjected to creep determinations, at a temperature in each case chosen in view of the recognized uses for such materials at those temperatures, and at three loads, chosen to produce creep rates of the order considered allowable in industrial use. These creep tests would continue for *three years* and be made under all the refinements of the A.S.T.M.-A.S.M.E. Tentative Code.

Meanwhile, the same materials would be subjected to the various accelerated or short-cut methods that have been proposed, and various methods of extrapolation from one load to another that have been suggested, would be applied. From these methods the rate of creep for three years would be predicted according to the procedure used by the proponents of each method, and later compared with the actual results of the three-year test. Material would be held for use in other short-cut methods that may arise later, and for possible international comparisons of methods.

Instead of waiting for comparisons of each short method with regular creep to be made upon whatever materials the experimenter has available, with consequent difficulty of correlation, *simultaneous* correlation would thus be obtained on the *same* materials.

Obviously, such a program would involve considerable expense, though the Committee already has the promises of many of its own members for cooperation in the program, and the minimum program outlined above could not be started without assurance of sufficient interest and support to make its completion certain. That the American and British Joint Committees independently laid out three-year programs is evidence that all investigators realize that sustained effort is required for progress.

Designers and users, as well as producers, of alloys for high temperature equipment, such as the power plant, oil, and furnace industries are therefore invited to inform the Secretary of the Joint Committee, Mr. N. L. Mochel, Westinghouse Electric & Manufacturing Company, Lester Station, Philadelphia, Pa., whether they would like to see such a correlation program taken up by the Joint Committee. The Committee desires to be as responsive to the wishes of the interested engineering industries as the available financial resources will allow. While its own membership feels that the project outlined should be undertaken at the earliest feasible moment, before committing itself to a "three-year plan," it seeks comment and guidance on the selection of this or alternate activities that may be deemed more pressing by the engineering world. The Committee will not assume, in the absence of either adverse or favorable comment that "silence gives consent." Should the program not be sufficiently welcome to the industries concerned so that a definite desire for its pursual is registered with the Committee, the project will not go forward. Comments to Mr. Mochel are therefore earnestly requested, whether pro or con. The comments will be considered at an early meeting of the Committee.

THE JOINT COMMITTEE ON EFFECT OF
TEMPERATURE ON THE PROPERTIES OF METALS

Earl C. Smith, Chief Metallurgist of Republic Steel Corporation, Youngstown, Ohio, addressed a meeting of the Boston Chapter of the American Society for Steel Treating, Jan. 5, at Massachusetts Institute of Technology, Cambridge, Mass., on the subject of "Stainless Steels." Mr. Smith's address was supplemented by a large display of stainless steel products illustrating various methods of fabrication. Mr. Smith is well known in the field of ferrous alloys, having been prominently connected with research work in that field for a number of years with what is now the Central Alloy Division of Republic at Massillon, Ohio. He was, in fact, one of the pioneers in the metallurgy and production of modern ferrous alloys. He discussed the stainless alloys as a whole, identifying those which are classed as stainless steels. Mr. Smith further discussed the production, working methods and qualities of the stainless steels, demonstrating their workability with actual products. He also described the rapid progress made by stainless steel in a number of industrial fields, citing many examples of successful applications.

Major R. A. Bull, member of the Editorial Advisory Board of *Metals & Alloys,* consultant on steel casting practice, Chicago, and for 13 years director of the Electric Steel Founders' Research Group, has been retained to devote part of his time as consultant and mid-west representative, with office at 541 Diversey Parkway, Chicago, by the Ajax Electrothermic Corp., Trenton, N. J. Major Bull is a past president of the American Foundrymen's Association and received the Seaman gold medal for his contributions to foundry practice.

A.S.T.M. Meetings

1934 A.S.T.M. Regional Meeting—Wardman Park Hotel, Washington, D. C. March 7.

1934 Group Meetings of A.S.T.M. Committees—Wardman Park Hotel, Washington, March 5 to 9 inclusive.

Annual Meeting—Chalfonte-Haddon Hall, Atlantic City, June 25 to 29 inclusive.

The technical feature of the Regional Meeting will be a Symposium on Outdoor Weathering of Metals and Metallic Coatings, sponsored jointly by our Committees A-5 on Corrosion of Iron and Steel and B-3 on Corrosion of Non-Ferrous Metals and Alloys. A statement listing the papers and giving other details of this meeting will be sent in the near future.

E. I. du Pont de Nemours & Company, Inc., Wilmington, Delaware, announces the purchase of the metal degreasing business of the Carrier Engineering Corporation, Newark, New Jersey. This business formerly was conducted by the Carrier Metal Cleaning Division. The transaction involves the sale of patents, trademarks and good will of the Carrier Vapor Degreaser machine and of the well-known solvent, Cecolene, used in connection therewith. The R. & H. Chemicals Department of the du Pont Company will continue to manufacture Cecolene and is prepared to supply this solvent in any quantities to present users of Carrier Vapor Degreaser equipment. Future orders for Cecolene should be sent to The R. & H. Chemicals Department of the du Pont Company at Wilmington, Delaware, or to its district offices in the following cities: Baltimore, Boston, Charlotte, Chicago, Cleveland, Newark, New Orleans, New York, Philadelphia, Pittsburgh, San Francisco.

Karl Kautz, ceramic engineer, has joined the staff of Republic Steel Corporation and will specialize in research and field service on enameling sheets, according to announcement by Earl C. Smith, Chief Metallurgist of Republic. A graduate of Ohio State University with the degree of Master of Science, Mr. Kautz's experience includes ten years of work with prominent firms in various branches of vitreous enameling. He is also known as the author of several papers on colored glazes which have appeared in the Ceramic Journal. For two years Mr. Kautz was in charge of the enameling plant of American Range & Foundry Co., East St. Louis, Ill. Following that he was Ceramic Chemist with Northwestern Terra Cotta Co., St. Louis, Mo., for four years. Prior to his connection with Republic he was Ceramic Chemist with Abingdon Sanitary Mfg. Co., Abingdon, Ill. Mr. Kautz's headquarters at present are at Republic's Central Alloy Division at Massillon, Ohio.

Harry W. McQuaid has joined the metallurgical staff of Republic Steel Corporation, according to announcement made by Earl C. Smith, Chief Metallurgist. Mr. McQuaid, who is nationally known as an authority on carburizing steels and case-hardening methods, is the leading pioneer in grain size control and collaborated in the development of the McQuaid-Ehn test which bears his name. He will devote his time with Republic to research and development work. Other changes incident to the broad metallurgical program under way at Republic include the transfer of Howard W. Burkett from Youngstown to the post of metallurgical engineer of the Buffalo district; the appointment of Elmer Larned in a similar capacity in the Chicago district and the acquisition of Harold T. Blair, metallurgical engineer, who will specialize in tin plate products. Karl Kautz, ceramic engineer, also has joined the Republic organization, and will specialize in research and field service on enameling sheets. M. J. R. Morris and E. R. Johnson will continue in their respective metallurgical capacities in the Central Alloy district, where all of Republic's stainless steel and much of the alloy steel are produced.

Theodore M. Gloeckner, associated with the sales organization of Union Drawn Steel Co., Massillon, O., for more than 15 years, became district sales manager for the Philadelphia territory, Jan. 1. He has spent the greater part of these years in the Philadelphia office of the company, 2030 Fidelity-Philadelphia Trust Building, and for the past 18 months has been in charge.

A. A. Stevenson

Archibald A. Stevenson, whose whole life was spent in the iron and steel industry, and who for over 40 years was connected with, and for more than 20, vice-president of, the Standard Steel Works Company, died December 15 at the age of 71.

He was a pioneer. While with the Cambria Iron and Steel Company he worked on the toughening of axles and forgings and in 1887 designed the equipment for their commercial treatment. This was one of the earliest commercial heat-treatment installations.

Around 1890, he adopted deep etching of steel railway tires at the Standard Steel Works, one of the earliest applications of deep-etching commercially.

In 1898 he became impressed with Sauveur's application of the microscope to metallurgy and got the Standard Steel Works to install one of the first four microscopes that were used in the steel industry.

He was always interested in maintenance and improvement of quality by research and testing and was especially active in the affairs of the American Society for Testing Materials, serving as its president in 1916, and in the work of the American Standards Association of which he was chairman in 1920-21.

He was chairman of the Gun-Howitzer Production Club during the war. This club, made up of producers of heavy gun forgings, swapped information as to methods of production and did effective work in speeding up production.

Mr. Stevenson's friendly personality, high technical attainments and breadth of vision were all brought to bear on any task he undertook.

Ryerson Builds New Plant Extension

Joseph T. Ryerson & Son, Inc., are among the few concerns that are extending their facilities at this time. They already have underway an extensive addition to their St. Louis Steel-Service Plant. The new building will greatly increase facilities for storing and dispatching steel and allied products from that point. New, modern offices equipped with an air conditioning and cooling system will be included in the unit. The greater part of this new addition will be given over to the warehousing of products requiring particular protection from atmospheric changes. A circulating warm air heating system will provide the necessary distribution of heat for the proper storing of sheets, tool steels, welding rod, cold rolled bars, bands, hoops and other high grade steels. The new heated area will be almost three times larger than the present heated plant. The greater proportion of this new space is heated but there is also being built a large span of the unheated type for the storage of mild steel bars, etc., for cutting, shearing, loading and other facilities. Unusual truck loading facilities are being provided. Motor trucks will back into a recessed pit in the new span, bringing the floor of the truck about level with the floor of the building and thus simplifying the moving of material. One new crane will be placed in operation and another crane and runway in present use will be extended through the new building. The new spans are also served by railroad spurs for inside loading and unloading of products. Plans for increased stocks are well under way. Many new products and sizes will be added, making immediately available to the St. Louis area the largest and most diversified stocks of steel and allied products. In addition to this St. Louis unit, the Ryerson Company is serving nine other industrial centers with plants at Chicago, Milwaukee, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Philadelphia and Jersey City.

EDITORIAL COMMENT

(Continued from page A 19)

of research of this type brings no dividends. The information must be used.

Utilization

Thus, in order to cash in on research, the marketing or utilization step must be made. If the executive does not so contrive that this step is automatic and pre-arranged, he is, in effect, having the research done only for his mental satisfaction—perhaps in order to say that he has a research department—but not for the sake of dividends. The research man is not often so situated that he can reach the Board of Directors directly and himself lay the economic situation and the technical facts before them in such fashion as to secure the necessary appropriation for commercialization. He must ordinarily rely on an executive for this step and unless the executive does take it, the result is like the inscription on an old tombstone we once saw:

> "She ne'er op'ed her eyes to see the dawn,
> But died some hours before she was born."

Scenting a new trail

Conversely, if the executive is convinced that the economic trend is such that a current research will not be usable, even if wholly successful technically, he should promptly shift his research staff to other more potentially fruitful problems. Half the battle in research is knowing when to stop, when it is time to shift the attack to another flank.

Indeed, one of the important qualifications of an executive who is steering a research program, is the ability to follow up a new trail, to leave the rabbit track and follow the fox. Since research is dealing with the unknown, anything may turn up in the course of the experiments and at any moment a result may appear that is of no use at all for the particular object in view, but just the answer to some other problem. One man's mind is less likely to ferret out the application of the "unsuccessful" result to some other problem than are the minds of a group. Hence, the possibilities of the by-products of his work are less likely to be detected by the lone research worker than when he can discuss them with others. The lay mind can often see the off-the-trail possibilities better than the technical mind, so the executive should be careful to see that negative results are reported to him as well as positive ones.

Some types of research worker, however, tend to turn off at each sidetrack that appears and never get back to the main track. The executive should often stop to consider whether the research projects are getting side-tracked, and if so, whether the side-track should or should not be made the main track.

Patience

But if the attack is really being made on the right track, the executive should be patient. It is a fallacy to assume that if 10 men could solve a problem in 10 years, 100 men could do so in one year. As Kettering is reported[5] to have phrased it, two hens can't hatch a setting of eggs in a week and a half.

Sustained effort over a reasonable period will bring results more cheaply than high pressure, "rush, rush" methods. Even sustained effort is not always advisable for sometimes one gets as far as the track will carry him; he reaches "the end of steel." Once a problem is clearly outlined and has progressed sufficiently to show that there will be great difficulty in solving it by conventional modes of attack, so that one is up against a stone wall, it is normally wise to drop the problem from the active list. The effective research man, however, holds such problems in the back of his mind, impressed upon his consciousness so that he automatically correlates new facts and new ideas, as they turn up in other work and in the literature, in their bearing on the unsolved problem, until a feasible mode of attack does present itself, when he may resume the recessed problem and carry it through to a successful finish. Hence, it often pays to define and to start problems just to get them into the thought-processes, there to wait for the right set of conditions to arise for intensive attack. The time to start a research problem is not just at the moment that the answer must be had, but before it.

Hence, the executive who strengthens his levees before the flood rather than during the flood is the one whose research department pays.

Research requires time for thought

The executive should realize that research is part experiment and part thought, so that it is necessary not only to provide the necessary equipment for the experiments but also the necessary environment for the thoughts. A research man trying to serve two masters, production and research, harassed with customers' complaints, trouble-shooting and routine control, surrounded by plant hurly-burly, cannot accomplish as much, hour for hour, in the time he does devote to research, as the man whose job is solely or primarily research, and who can find a quiet spot in which to mull over his results, see where they are leading him, and decide what to do next.

Close enough contact with the conditions under which the results of the research must be utilized to enable the worker to keep his feet on the ground is essential, and an exhilarating, but not too irritating, pressure for progress and for final results is helpful. But there is a happy medium, between the rush of the commercial plant and the lethargy of the academic cloister, in which research minds function best, and the management can often make or break a research problem by the environment it does or does not provide.

The executive's part

If an executive can diagnose conditions so that he can envision the type of information he is going to need a few years hence, if he will support his research staff not only with adequate equipment and suitable environment, but as well with encouragement and appreciation while they are stumbling along the untrodden ways toward the goal, and most of all, if he will promptly utilize the new facts they gather for him, he will do much toward taking the gamble out of his firm's research activities. Research will never have the certainty of an investment suitable for a widow, but it can be made to be a "business man's investment."

The coming series

In the series of personal experiences or research "case histories" that is to follow, the role of the executive will appear in concrete instances rather than in the vague generalities of this editorial. The series will show how metallurgical research has been made successful through proper executive guidance and coöperation, in a variety of organizations, large and small.

H. W. Gillett

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[5] P. de Kruif. Boss Kettering. *Saturday Evening Post,* Vol. 206, Aug. 26, 1933, page 58.

The Bristol Company, Waterbury, Conn., announces that in order to serve the Canadian market still better and to expand and consolidate its present Canadian service laboratory of 12 years standing so as to include sales, service and manufacturing, a separate company, The Bristol Company of Canada, Ltd. has been incorporated. Factory and general headquarters will be located at 64 Princess St., Toronto, Ont., where Bristol recording, indicating and control instruments will be made. J. S. Mayberry, graduate engineer of Toronto University, and for 10 years with the parent company, has been appointed manager.

Headquarters of the American Society for Testing Materials have been moved from the Engineers' Club Building, 1315 Spruce Street, Philadelphia, to more adequate offices in the Atlantic Building, 260 S. Broad Street in the same city. The present offices have been occupied for the past 14 years. A large and more attractive Board Room has been planned and most important, an adequate Reception Room and Members' Lounge will be provided. Greatly improved facilities for meetings of administrative committees will be available. The new rooms are excellently suited to the present needs of the Society and for some little time in the future. Friends of A.S.T.M. are cordially invited to inspect the new headquarters. They are convenient to railroad stations, hotels and clubs, being just a half block from the Engineers' Club.

GENERAL (0)

The Porphyry Coppers. A. B. Parsons. Published by American Institute of Mining & Metallurgical Engineers, sponsored by the Rocky Mountain Fund, New York, 1933. Cloth, 6¼x9¼ inches, 581 pages. Price $5.00. The book consists of 23 chapters, 13 of which are devoted to the history of 12 so-called porphyry copper mines. Two chapters are devoted to Utah Copper Co., and one each to Morenci, Nevada Consolidated, Braden, Miami, Ray Consolidated, Chino, Inspiration, Chuquicamata, New Cornelia, Copper Queen, and Andes. The history of these large mines has been handled in a most excellent manner by Mr. Parsons. Instead of cold historical dates and production data the author has instilled the personal element into his description of each mine. The role of the engineer and financier in making mines out of what a third of a century ago appeared to be hopelessly too low-grade deposits has been the foundation of the historical chapters. Apart from one's interest in copper, the story of the men who made the mines in the face of obstacles and skepticism makes interesting reading.

The 13 chapters describing the mines are preceded by two chapters entitled, ''An Achievement of Engineers'' and ''Varied Utility of Copper.'' The 7 chapters following those devoted to the mines cover Geology, Prospecting and Estimating Ore, Power-shovel Mining, Underground Mining, Concentration, Smelting, and Leaching. The final chapter is entitled, ''Building the West.''

The reviewer recommends reading Chapter 16 ''Geology'' immediately after Chapter 2. The 12 mines covered are not all strictly speaking porphyries, but the author describes in the chapter on Geology what he means by ''porphyry'' and why he includes the schist deposits of the Miami and Ray districts as porphyries.

In the opinion of the reviewer the later chapters in the book are not up to the quality of those devoted to the historical development of the mines.

It is an extremely difficult task to write a popular treatise on technical subjects and still remain technically correct. Since, however, the prime purpose of the book is to give a historical account of the developments of various copper porphyry mines, the reviewer will not quibble about the technical accuracy of the subject matter in these various minor chapters. Several of these chapters might have been omitted without detracting seriously from the worth of the book. Specifically, one may question why the chapters on concentration and smelting are included at all in a book on ''The Porphyry Coppers.'' The development of porphyry copper mines was not responsible for the improvements in flotation. Reverberatory smelting practice was changed because of changes in methods of concentration. Since the subject matter in the chapters on concentration and smelting is so elementary and since the development of concentration and smelting methods are not due solely to porphyry coppers there is good reason to question why they are included.

The tabloid versions of geology, prospecting and estimating ores, and on mining methods are adequate. The chapter on leaching is largely devoted to the history of and leaching data on the New Cornelia, Inspiration and Chuquicamata plants.

Only 18 pages are devoted to Andes, and a large part of the chapter is devoted to the financing of the property. No description is given of the leaching plant.

The author has done a worth while job. One reads the book more like a novel than a history. The book is profusely illustrated with photographs of men and plants, and with various diagrams and sketches. The printing is excellent and is virtually free of typographical errors. John D. Sullivan (0) -**B**-

Textbook of Physical Chemistry. Vol. 1. J. Newton Friend. J. B. Lippincott Company, Philadelphia, 1933. Cloth, 6½x9 inches, 501 pages. Price $7.50. This initial volume deals with general properties of elements and compounds. No outline is given of what the contents of the succeeding volume or volumes will be. The material has been chosen ''as that found most helpful to senior students at Birmingham Technical College.''

The book is designed as a college text book. No references are given. Where an investigator's name is used, the year of the publication of the article in question is also given, and the student is expected to hunt the reference up by means of abstract journals.

This particular volume deals with metals only as examples of physico-chemical phenomena, and since the chief subjects covered are gas laws, vapor pressure, viscosity, surface tension, solubility, adsorption, colloids, etc., there is little of direct interest to the metallurgist.

One of the few comments on metals states that β iron is ''now usually regarded as a solid solution of γ iron in α iron,'' the conversion of γ not being complete till A_2 is reached. While that particular statement would raise doubts in the minds of many metallurgists as to the general accuracy of the book, the traditional physical chemistry is correctly and clearly presented. H. W. Gillett (0) -**B**-

Methods for Study of Metallic Alloys. (Les methodes d'etude alliages métalliques.) L. Guillet. 2nd Edition. Dunod, Paris, 1933. Paper, 6½x10 inches, 859 pages. Price 203 Fr. This text book, by a distinguished author, naturally contains very much of interest and value. Nevertheless, it falls short of the ideal. It is rather more concerned with listing a number of ways to determine a given property and showing cuts of a variety of apparatus for the purpose than in discussing what the data mean when one has them or indicating which of various types of apparatus is the more serviceable.

Many old pieces of equipment are shown and described that would be of interest only to the historian, not the modern investigator.

Equipment marketed by French firms or used for research purposes by French investigators is discussed almost to the exclusion of that developed in other countries, and the references are overwhelmingly French even though the subject at hand may have been more fully dealt with by writers of other nationalities. Such literature citations as are made to articles in English are prone to show amusing misprints, as if set from long hand and proof-read only by someone with a blissful ignorance of the English language.

Quite a number of relatively new pieces of apparatus and modes of study are described and considerable revision has been made to the first edition, of 1923, but the revision is spotty in that many new things of as great importance as those included, have been omitted.

The author mentions thermoelectricity, corrosion, testing of electroplated deposits, viscosity (i.e., creep), repeated stress, torsion and wear, as subjects on which it was necessary to make radical revision of the first edition. Yet the sections on corrosion, creep, fatigue and wear tell very little of the actual utility of such tests or of the dangers of attempts to interpret accelerated laboratory results in terms of service. The treatment of X-ray methods is sketchy, that of chemical analysis so brief as to be of little value.

The classical discussion of phase rule diagrams is included, as is considerable material on thermal analysis, electrical resistance, magnetic properties, the usual type of material on metallography and macrography, tensile and impact testing, etc.

Probably the most useful part of the book is the extensive discussion of dilatometry according to Chevenard.

Metallurgical data, illustrative of the methods under discussion, and quite often rather well up to date, are included and an index makes most of this accessible.

The book will be of some value for reference but on the whole will not appeal strongly to other than French readers. H. W. Gillett (0) -**B**-

Engineering and Metallurgical Research During 1932. *Mechanical World & Engineering Record*, Vol. 93, May 5, 1933, pages 439-440; May 12, 1933, page 458. Articles deal with the report of work carried out at the National Physical Laboratory. Investigations touched upon among others are: Gage testing, hardness tests on thin metal coatings, resistance of metals to wear, fatigue of single crystals of metals, effect of surface conditions on fatigue of steels, lubrication research, creep at high temperatures, welded structures, molten metals, metallurgical analysis, light alloys, cracking of boiler plates. Kz (0)

PROPERTIES OF METALS (1)

Pitchblende and Radium. *Canadian Chemistry & Metallurgy*, Vol. 17, Jan. 1933, page 9. An abstract. A symposium dealing with the historical development of Ra, refining and concentration methods and means of measuring the amounts of Ra present in an ore or concentrate. Chemical analyses are superseded by measurement of the radio activity, due to the minute quantities present. α rays are the least penetrating and carry 2 charges of electricity, β rays carry 1 charge of — electricity with a velocity about 10 times greater than alpha rays, while γ rays are exceedingly penetrating with a vibration of short wave length. WHB (1)

Recuperation of Electric Resistance and Hardness of Copper, Silver and Gold, and Platinum and Palladium from the Results of Cold-Working. (Die Erholung des elektrischen Widerstandes und der Härte von Kupfer, Silber und Gold, sowie von Platin und Palladium von den Folgen der Kaltbearbeitung.) G. Tammann & K. L. Dreyer. *Annalen der Physik*, Series 5, Vol. 16, Jan. 1933, pages 111-119. Plastic deformation of a metal, rolling, drawing, etc. increases electric resistance and hardness. To determine the change from the original material (in soft state) the deformed material is gradually heated and the 2 properties measured. The individual tests up to a point where the material assumes the original value are given in diagrams for all the materials. Ha (1)

Magnetism of Precipitates of Colloidal Silver. V. F. Vaidyanathan & B. S. Puri. *Nature*, Vol. 129, Jan. 30, 1932, page 170. Magnetic properties of graphite, Sb, Bi and Au are modified by colloidalisation. Two forms of colloidally precipitated Ag have been investigated and the specific susceptibility found was for (1) 0.166×10^{-6} and (2) 0.133×10^{-6} while that of Ag in the massive state is: 0.2×10^{-6}. Au and Ag are known to possess paramagnetic atoms, but built up diamagnetism only in the massive state. Changes depending on their crystal and block structure can therefore be expected in them. Kz (1)

On Magnetic Effects in Iron Crystals. A. G. Hill. *London, Edinburgh & Dublin Philosophical Magazine & Journal of Science*, Vol. 14, Oct. 1932, pages 599-604. Gives details of experimental work. The lower the temperature the greater is the magnetic lag. 2 graphs show the magnetization curves to be linear. RHP (1)

The unusual metal or alloy of today may be the usual metal of tomorrow.

You will profit by looking over this section as well as the sections on non-ferrous and ferrous alloys.

The Physical Properties of Zinc at Various Stages of Cold-rolling. R. Chadwick. *Institute of Metals, Advance Copy* No. 627, Mar. 1933, 24 pages. Annealed strips 0.10" thick of electrolytic Zn, and Zn containing small amounts of Cd, Fe or Mg were cold rolled to reductions amounting to as much as 80%. Diamond-pyramid and scleroscope hardness were determined immediately after rolling and after periods up to 3 months. Tensile properties and creep rates for high loads were also determined. For small reductions hardness and strength of Zn increased and increase was permanent. For somewhat larger reductions these values also increased, but materials softened on aging. Creep rates for a stress of 5000 lbs./in.^{2} increased as % reduction increased. A typical cold-worked structure was produced by rolling, but an annealed structure took its place after aging. Effects of small amounts of Cd, Fe or Mg on change in properties due to rolling were small, but their influence on change in properties on aging was pronounced. Previous work on properties of Zn is reviewed. Mechanism of cold working is discussed, and phenomena are explained on assumption that amorphous metal is formed during working. Effect of alloying elements is to stabilize amorphous phase. 27 references. JLG (1)

The Electrical Conductivity of Aluminium Wire. A. J. Field & J. H. Dickin. *Institute of Metals, Advance Copy* No. 630, Mar. 1933, 16 pages. Al wire is usually made by hot rolling 4" x 4" bars to rod from 0.5" to 0.25" in diameter and then drawing. Temperature of hot rolling influences final conductivity of commercial Al of 99.6% purity. Highest conductivity results from rolling between 410° and 460° C. Speed of rolling likewise influences conductivity. A maximum increase in conductivity of hard-drawn wire results from annealing at 325° C. As annealing temperature is raised above this temperature conductivity decreases. Rate of change of tensile strength and conductivity of cold-worked wire on holding at temperatures up to 280° C. for tensile strength and 340° C. for conductivity is shown. Holding at 150° C. for 4 hr. increases conductivity and decreases strength. Heating to 300° C. prior to drawing increases conductivity. Practical applications of heat treatment are discussed. Requirements of 60% conductivity and tensile strength between 22,000 and 28,000 lbs./in.^{2} can be met by drawing Al of 99.6% purity from unheat-treated rod. It is practicable to produce wire of commercial purity of more than 62% conductivity by giving a heat treatment at 300° C. Influences of various amounts of Si and Fe on conductivity are shown. A given weight of Si has a greater effect than a similar weight of Fe. Change of conductivity with heat treatment is due chiefly to variation in solubility of Si with temperature. 14 references. JLG (1)

Manganese. General Information. Robert H. Ridgway. *United States Bureau of Mines, Information Circular* 6729, June 1933, 29 pages. Discusses properties of Mn, Mn minerals and mode of occurrence, world sources and production, uses, markets, etc. An extensive bibliography is given. AHE (1)

Change of Phase by Reflection at Very Thin Metallic Films. (Variations de phase par réflexion sur couches métalliques très minces.) P. Rouard. *Comptes Rendus*, Vol. 196, Jan. 30, 1933, pages 339-341. Previous work has given discordant results. Metal (Ag) was deposited by cathodic sputtering on one face of a plane parallel glass plate, thickness of film varying from 0 to a certain maximum. Film was studied by method of Buisson and Fabry. The change of phase first consists of a retardation, but as the thickness of the film increases, the change passes through 0 and becomes an advance tending finally towards 0.30 wave length. OWE (1)

The Influence of Impurities on the Properties of Lead. R. S. Russell. (Introduction. J. Neill Greenwood). *Proceedings Australasian Institute of Mining & Metallurgy*, No. 87, Sept. 30, 1932, pages 135-166. Commercial Pb containing 0.008% total impurities has been refined by electrolysis to contain 0.002% impurities. The electrolyte was a solution of Pb $(ClO_4)_2$. The electrolytic Pb was much more susceptible to the influence of distortion and annealing than the other Pb, that is, it recrystallized more easily and upon less provocation. Electrolytic Pb recrystallized completely upon being distorted 5% and standing at 18° for 1½ hr. The other Pb showed only partial recrystallization after 20% distortion and standing for 24 hrs. A Pb specially refined by fire methods to 0.003% impurities gave results like the commercial Pb. A solution of $(NH_4)_2MoO_4$ in dilute HNO_3 is recommended as a new etching reagent for Pb. AHE (1)

Anomalous Diamagnetism of Bismuth. S. R. Rao. *Nature*, Vol. 129, Apr. 9, 1932, pages 545-546. Bi when electrically or mechanically colloidalized shows a loss in its diamagnetic susceptibility value. This fact has been attributed to oxidation, but the author concludes that the drop of the susceptibility value with decreasing particle sizes is a genuine effect with reference to Bi. Kz (1)

PROPERTIES OF NON-FERROUS ALLOYS (2)

Some Special Alloys for Non-Ferrous Metal Mixers. Wesley Lambert. *Metal Industry,* London, Vol. 42, Jan. 13, 1933, pages 49-50. Alloys of Cu and Sn with P, of Mn, Mn-Cu, Si, Al, Ni, B are reviewed and their principal characteristics and behavior explained. B is at present used only in a Mn-B alloy with 20-25% B and recommended for use particularly in the compounding of Ni alloys, and also other non-ferrous alloys, as an "improver." Be-Mg alloys are already used to a fair extent, Be serving as hardener. Na is used as deoxidizer for Cu, Be as hardener for special Babbitt metals, Li is said to degasify Cu and improve its conductivity and mechanical properties; as little as 0.003 to 0.01% is said to be effective. Also S and galena are used sometimes as "holder-up" in mixing metals and Pb for making bronzes. Ha (2)

Electrical Properties of Diluted Solid Solution Alloys. III. Resistance of Cu and Au Alloys. Regularities of Increase of Resistance. (Elektrische Eigenschaften verdünnter Mischkristallegierungen. III. Widerstand von Kupfer- und Goldlegierungen. Gesetzmässigkeiten der Widerstandserhöhungen.) J. O. Linde. *Annalen der Physik,* Series 5, Vol. 15, Nov. 1932, pages 219-248. Increase in electrical resistance of Cu by additions of metals of atomic numbers 25-33, 45-51 and 77-80 and its dependence on temperature was investigated in range from +18° to —190° C. Solubility of Ru, Os and Mo in Cu is extremely small (at 900° C.) When adding b-elements of a horizontal in periodic system increase is proportionate to square of horizontal distance of added metal to base metal; a-elements do not show this simple relation. Ha (2)

New Demands on the Brass Foundry. J. Arnott. *Foundry Trade Journal,* Vol. 48, Jan. 12, 1933, pages 27-28. Hardness of bronze can be increased by addition of Ni. Further hardening can be obtained by addition of Si. Addition of Pb is of advantage for diminishing friction. Mn brass is strong enough for heavy hydraulic castings, though it has a high shrinkage. Non-ferrous alloys, e.g., silicon-Monel, to resist action of high temperature steam are described. Al-Si alloys for reducing weight of machinery and Cu-Si alloys to replace gunmetal, where Sn is expensive, are mentioned. OWE (2)

The Solubilities of Copper, Manganese and Some Sparingly Soluble Metals in Mercury. Nevill M. Irvin & Alexander S. Russell. *Journal Chemical Society,* Mar. 1932, pages 891-898. Solubilities of metals of atomic numbers 22-29 and of Mo, W and U in Hg were determined by preparing an amalgam of each metal, separating solid from liquid phase by filtration through sintered Jena glass and analyzing liquid phase chemically. Only Cu and Mn have solubilities greater than 1 in 10^7, their values being 0.0020% and 0.0010% respectively. Ha (2)

Some Aluminum Alloys for All Kinds of Castings. (Ueber einige Aluminiumlegierungen für Gussstücke jeder Art.) *Automobiltechnische Zeitschrift,* Vol. 35, Sept. 25, 1932, page 443. A few compositions of Al alloys are mentioned. For instance 92% Al and 8% Cu which has about 14 kg./mm.^{2} tensile strength; an alloy of 89.8% Al, 7.5% Cu, 1.5% Zn, 1.2% Fe shows still better values. Very dense castings for use in pumps, cylinder, etc. are made of 88.5% Al, 10% Cu, 1.25% Fe, 0.25% Mg. Alloys of 87.5% Al, 10% Zn, 2.5% Cu show 15.5 kg./mm.^{2} tensile strength with 2% elongation; 83.75% Al, 7% Zn, 7.75% Cu, 1.5% Fe has 19.3 kg./mm.^{2} with 4.5% elongation. Very light alloys are made of 95% Al and 5% Mg for motor frames and other parts; the specific gravity is only 2.5, the tensile strength about 19 kg./mm.^{2} at elongation. Ha (2)

Some Features Worth Knowing and to be Considered with Regard to Annealing and Quenching of Bronze Castings for the Manufacture of Automobiles and Motors. (Beachtens- und Wissenswertes über das Glühen und Abschrecken von Bronzegussstücken für die Automobil- und Motoren fabrikation.) *Automobiltechnische Zeitschrift,* Vol. 35, Sept. 25, 1932, page 442. The influence of annealing, quenching and tempering on the physical properties of bronze alloys has been investigated, the results of such tests are reviewed and compiled. A bronze of 88.5% Cu, 9.5% Sn and 2% Zn was annealed at from 600° to 800° C. for ½ hr. and slowly cooled. While elastic limit and Brinell hardness remained approximately the same tensile strength increased from 30.4 in untreated sample to 34 kg./mm.^{2} in treated sample, elongation from 26.5 to 58% and reduction of area 23.6% to 38%. When sample was quenched in water, however, values were reduced considerably and many cracks developed. Al bronzes with 5-10% Al can be greatly influenced by heat treating. An alloy of 89% Cu, 10% Al and 1% Fe can be easily hardened and tempered and behaves similar to hard steel. Heated to 950° C. and quenched in water elastic limit increased from 13.9 to 28.9 kg./mm.^{2}, the tensile strength from 51.8 to 68.2 kg./mm.^{2}, Brinell hardness from 100 to 240, the elongation decreased from 19.5 to 1%. Subsequent tempering removes part of the improvement. In using parts for automobiles of such alloys the properties can be made to fit the use by proper treatment. Ha (2)

Metallurgy of the Production of Nickel Silver. (Metallurgische Betrachtungen zur Herstellung von Neusilberguss.) Edmund Richard Thews. *Chemiker-Zeitung,* Vol. 56, Dec. 3, 1932, pages 961-963. Ni silver is an alloy of Cu, Zn and Ni of variable composition. The elongation increases with increasing Cu content. For cold rolling the Zn should be less than 30%, Cu over 50%. Ni is usually between 10 and 30% and Zn between 16 and 30%. Castings contain more Zn, sometimes up to 57%. A tabulation of the composition of many brands of Ni silver alloys is given. Addition of Fe increases the strength and 1-1.5% Fe has as much whitening effect as 2-4% Ni. With more than 2% Fe the alloys become brittle. Sn is objectionable for rolling, but is sometimes used in castings. Pb, not over 3%, may be added to improve machinability. .5-1.5% Al improves the density and strength providing the Ni is below 15%. With higher Ni, Al produces brittleness and undesirable casting conditions. W additions increase the electrical resistance. The castings solidify rapidly. If the metal is overheated it absorbs gas and some of the Zn volatilizes. The charge usually consists of brass and Ni. The metal should be cast 150-200° above the melting point, which is 1100-1300° C. Al, Mg, Mn or phosphor Cu are used as deoxidizers. The metal should stand 1 minute after deoxidizing. Large gates and risers are used. CEM (2)

Alloy Y (L'Alliage Y). Try-Chalons. *Revue de Fonderie Moderne,* Vol. 26, Nov. 25, 1932, pages 430-431. This is a refinable alloy of 92.5% Al, 4% Cu, 2% Ni and 1.5% Mg and has a density of 2.80, a shrinkage of 1.29% and it solidifies between 630° and 520° C. Cast in sand it has an elastic limit of 7.8 kg./mm.^{2}, in a metal mold 8.3 kg./mm.^{2} which by heat treatment can be brought to 11.2 kg./mm.^{2}. The tensile strength is 15-19 and 19-22 kg./mm.^{2} respectively and 28-31 if heat-treated. Brinell hardness 80-105, elongation 1-5%. It resists atmospheric attack and seawater very well. The best process of preparing the alloy, molding and casting are described; the heat-treatment consists preferably in an annealing at 500°-520° C., quenching in oil or boiling water, in certain cases in cold water, and in tempering, whereby the metal should be protected against oxidation. The best casting temperature is between 690° and 760° C. A few cases of application are given. 5 references. Ha (2)

Brass, Bronze, and Copper Alloys. W. R. Hibbard. *Metal Industry,* London, Vol. 40, Feb. 26, 1932, pages 242, 261-262. Reproduced from *American Metal Market.* Slightly condensed from a paper read at a Conference on Metals and Alloys under the auspices of the Cleveland Engineering Society and the Case School of Applied Science. See *Metals & Alloys,* Vol. 3, June 1932, page MA 159. WHB (2)

PROPERTIES OF FERROUS ALLOYS (3)

Some Molybdenum High Speed Steels. Joseph V. Emmons. *Transactions American Society for Steel Treating,* Vol. 21, Mar. 1933, pages 193-232; *Metal Stampings,* Vol. 5, Oct. 1932, page 616. Paper presented before Buffalo Convention, Oct. 1932. Hardness, strength, plasticity, microstructure and cutting quality of 9 Mo, 6 Mo-W and 7 miscellaneous alloy high speed steels are described. Mo is considered as an individual alloy, not as a replacement element for W. Response to heat treatment at different temperatures in hardness, torque and plastic deformation of various alloys is given. A lower heat treatment temperature (100°-150° F.), for Mo steel than for W brings out best properties. Melting point of carbides is lower in Mo than in W steels. Tempering temperatures are same for Mo steels as for W, but a narrower range for Mo both for hardening and tempering is indicated. Mo steels have equal hardness, but lower strength and plasticity and fewer carbides than W steels. Increase in C to appearance of a normal amount of carbides improves performance of Mo steels. Co and Ni additions show no improvement in qualities. Mo steels showed an average performance of 62% of the 18-4-1 type of W steel. W additions to Mo steel raises hardening temperature slightly, reduces size of martensitic needles, changing them to distorted or vermiform type, has little effect on hardness, definitely increases strength, gives more uniform plasticity and improves cutting quality. Too much W increases hardness with brittleness and poor cutting quality. Mo alloy with 15-30% as much W as Mo has a definite field of usefulness. Includes discussion. MS + WLC (3)

Relation Between Quenching Characteristics and the Resistance to Drawing of Alloy Steels Containing Difficultly Soluble Special Carbides (Sur les relations entre le pouvoir trempent et la stabilite au revenu des aciers speciaux contenant des carbures speciaux difficilement solubles). Edouard Houdremont, Herbert Bennek & Hans Schrader. *Revue de Metallurgie,* Vol. 30, Apr. 1933, pages 152-170. See "Stability and Retention of Temper of Steels Containing Certain Difficultly Soluble Carbides," *Metals & Alloys,* Vol. 4, May 1933, page MA 135. JDG (3)

High Strength Steel. Edgar P. Trask. *Marine Engineering & Shipping Age,* Vol. 38, July 1933, pages 240-248, 264. Physical properties and chemical compositions of Ni-, Cromansil-, and Chromador steel are compared. The analysis of Chromador steel is given as follows: 0.30% C, 0.70-1.0% Mn, 0.70-1.10% Cr, 0.20% Si, 0.25-0.50% Cu, 0.05% S, 0.05% P. Greater strength in Cromansil steel can be obtained by increasing the C content which also results in a decrease of the ductility, which is a desirable property in shipbuilding steel. Cromansil steel rolled with a Cu content is now under test to determine its resistance to the action of salt water, oil, and gasoline. In the article is shown by comparison the gain in economy in ship construction to be made by the use of superior steels where strength is needed and also by the use of Al where lightness but not strength is needed. Kz(3)

A New Structural Steel. *Engineer,* Vol. 155, Feb. 24, 1933, pages 188-189. *Shipbuilder & Marine Engine Builder,* Vol. 40, Apr. 1933, pages 153-154. The new steel is called "Chromador" steel and has been developed by Dorman, Long and Co., Ltd., a British company. It contains C not over 0.3%, Mn 0.7-1.0, Cr 0.7-1.1, Cu 0.25-0.5, Si not over 0.2, S and P not over 0.05% each. A graph is given showing comparative compression tests on rolled beams of Chromador steel and of ordinary mild steel. Comparative corrosion curves are also shown. Chromador steel has a guaranteed ultimate tensile strength of 37 to 43 tons/in.^{2} and a yield point of at least 23 tons, measured by the "drop of the beam" on ordinary structural sections ½" thick. With ½" specimens its elongation in 8" is guaranteed at a minimum of 17% and its reduction of area at 40% minimum. JWD + LFM (3)

The Plastic Character of Cast Iron. A. C. Vivian. *Mechanical World & Engineering Record,* Vol. 93, June 2, 1933, pages 522-524. Tests on cast iron bars of the following composition: T.C. 3.31%, Si 1.75%, Mn 0.63%, S 0.11%, and P 0.98% are described. They show that cast iron possesses plastic character in conjunction with elastic character. Referring to experiences encountered in testing cast iron pipes, which failed under pressure after machining when submitted to tests before machining, it is said that on a second loading within a period of a day or two the plastic character would not be restored, and the Fe would not then possess much inherent capacity to reduce highly localized stress concentration. Test results show that if a bar of cast iron is loaded most of the set becomes fixed in the material and for a considerable time afterwards the bar behaves in a truly elastic (i.e., brittle) manner. Remedy lies in increasing the plastic character of the iron used. Hematite irons in general have a higher plastic character than irons of more than 0.1% P. Kz (3)

High-Speed Steels, Their Constitution and Heat Treatment (Les aciers a coupe rapide, leur constitution et leur traitement thermique). Jos. Wagner. *Revue Technique Luxembourgeoise,* Vol. 24, Nov.-Dec. 1932, pages 149-157. Historical development of high-speed steel is briefly given; first kind was made in 1868 by Robert Mushet in Sheffield and contained 1.5-2% C, 1-2% Mn and 7-8% W. Cr and V were later added. The particular properties of these steels are due to transformations in chemical compositions and structure around the Ac$_3$ point. Carbides are formed, mostly Fe_3C, Cr_4C, WC and V_4C_3, they are enclosed in the pearlitic mass. The modern high-speed steel generally has a composition of 0.7 C, 0.1 Si, 0.1 Mn, 5.0 Cr, 19.0 W and 0.3 V; the pearlitic mass consists of Fe 80%, W 12-15%, C 0.5-0.6% and Cr 4%, while the complex carbides consist of Fe 34.5%, W 60%, C 3%, Cr 2% and V 0.5%. There exist therefore, 2 constituents composed of the same elements in different proportions. The Brinell hardness attained in

annealed pearlitic high-speed steel	248
weakly carburized martensitic steel quenched at 900° C.	524
strongly carburized austenitic steel quenched at 1300° C.	614
strongly carburized martensitic steel quenched at 1300° C. and drawn at 575° C.	667

W gives the steel a very fine crystalline structure and acts as hardener; it alloys with Fe in any proportion. Cr also acts as hardener, favors the martensitic formation and improves the tensile properties, it is an indispensable element in high-speed steel. V is used only in small quantities, its action is not quite explained, it seems to favor the forming of Fe_3C and V_4C_3 which latter is dissolved at the quenching temperature. Mo acts similarly to W, a double-carbide $FeMo_3C$ is formed. Co is added recently in about 5-6%, it favors the dissolving of the carbides. Other metals which have been tried are: U up to 6%, also favors solution of carbides in quenching; B should not exceed 0.1% as otherwise the forgeability is impaired; it is, like V, a strong deoxidizer and improves the hardness; Ti acts as deoxidizer and reduces the content of inclusions. Ha (3)

New Heat and Corrosion Resistant Steels. (Neue Wärme- und korrosionsbeständige Stähle.) H. Kalpers. *Technische Blätter der deutschen Bergwerkszeitung,* Vol. 23, Aug. 6, 1933, page 426. Properties, treatment and application of the following steels are reviewed: Izett steel, a low Mo bearing steel of the Vereinigte Stahlwerke particularly suitable for the manufacture of press welded drums, a heat and corrosion resisting Cr steel of the Böhler works also containing Ta. This steel (.2% C, 1% Si, 19% Cr, 8% Ta) showed no scaling after having been subjected to 1100°-1300° C. for 50 hrs. For special purposes additions of from .5-3.5% Mo proved advantageous. This steel also shows excellent corrosion resistance. The Krefeld Steel Works developed Ni-Cr-Mn steels with high hot tensile strength, resistance to oxidation and high resistance to deformation at high temperatures, being superior to Ni-Cr, Mn and similar steels. Such steels are advantageously used for valves, parts on gas and steam turbines and similar parts requiring high tensile strength, elasticity and resistance to deformation at elevated temperatures. GN (3)

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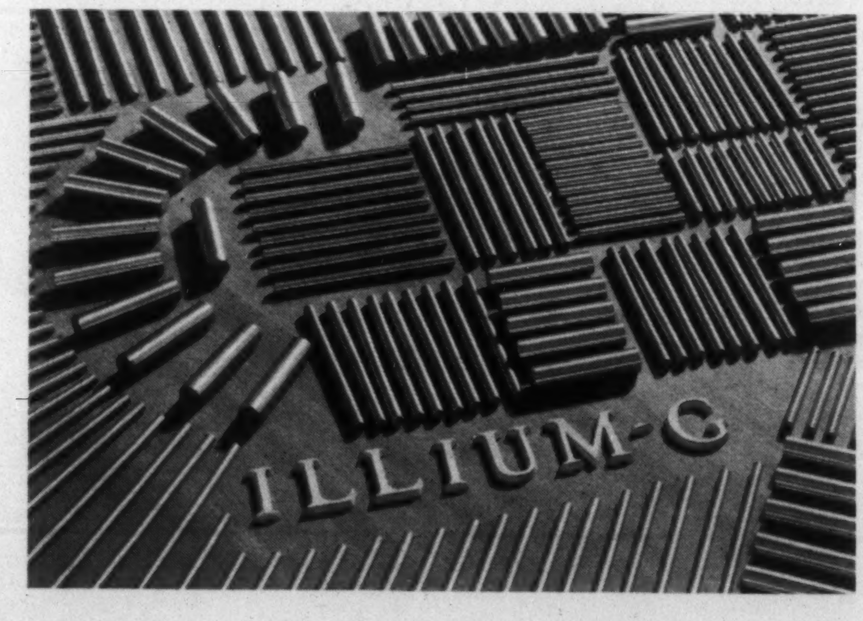

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CORROSION, EROSION, OXIDATION, PASSIVITY & PROTECTION (4)

Soil Corrosion Studies on Pipe Lines. K. H. Logan. *Gas Engineer,* Vol. 57, Mar. 1932, pages 167-171; Apr. 1932, pages 211-215. Presents results of examination of specimens of non-ferrous materials and metallic protective coatings removed from 45 soils after exposure of from 4-6 years. Included in test were samples of Cu and brass pipe, cast and forged brass fittings, galvanized pipe and sheet steel, Pb sheet, Pb coated pipe, and Pb coated and galvanized bolts. Data on rates of corrosion of steel pipe are also presented as a basis for comparison. Non-ferrous metals tested were found to resist corrosion somewhat better than steel, but they were not unaffected by soil action. 14 tables. WH (4)

Safety in the Pumping of Chemicals. James C. Lawrence. *Chemical Age,* London, Vol. 27, Dec. 3, 1932, page 526. Greatest hazards to be overcome in chemical pumps are from ordinary leaks at stuffing boxes and gaskets, and breakage from corroded or weakened casings. Number of actual injuries due to accidents or breakdown of chemical pumping equipment is probably low, but the potential hazard is always present on the normal unprotected pump. The continual damage and loss to industry in equipment, time and material is extremely high when considered as a total. Most chemical pumping problems can readily be made reasonably safe from leakage and breakage by using submerged pumps or pumps having no gland against the liquid head; other pumps should be provided with properly protected glands and castings, water-cooled stuffing boxes, and where conditions call for it, isolated from the operating area. VVK (4)

Resistance of Iron to Corrosion. H. Nipper & E. Piwowarsky. *Foundry,* Vol. 60, Dec. 1932, pages 36-37. Describes researches carried out to determine influence of the kind of graphite precipitation and of Si content (1.2 to 3.5%) on corrosion of gray Fe. Results show that in dilute acid the predominating factor is the number of local cells present, which means the relation of graphite contents to graphite surface. Extremely high grade polish on specimens caused somewhat greater resistance to corrosion. All melts appear to be immune to attack by 20% Na_2CO_3 or KOH solutions. VSP (4)

Corrosion costs industry many thousands of dollars. Are you keeping up-to-date on this important subject?

Preventing Corrosion in the Rayon Plant. Theo. R. Olive. *Textile World,* Vol. 82, Sept. 1932, pages 68-70. Use of Ni lining, glass supports, hard-rubber, Monel metal, Al, stainless steel, etc. in different parts of equipment and processes for artificial silk manufacture are discussed. These counteract the corrosive influences of chemicals used in processes. Ha (4)

Corrosion of Nickel and Monel Metal by Sulfured Grape Juice. E. M. Mrak & W. V. Cruess. *Industrial & Engineering Chemistry,* Vol. 25, Apr. 1933, pages 367-369. Tests indicate that sulphurous acid greatly increases corrosive action of grape juice on Ni, but not on Monel metal. In case of Monel metal some constituent of red grape juice, possibly anthocyanin pigments, causes a greater corrosion by the juice than sulphurous acid. In most cases Monel metal proved more resistant than Ni to corrosion by the media used in the tests. MEH (4)

Protection Against Corrosion of Iron Pipe Lines. (Korrosionsschutz von Eisenrohrleitungen.) E. Marquardt. *Der Bautenschutz,* Vol. 3, July 5, 1932, pages 73-82; Sept. 5, 1932, pages 97-109. Various chemical processes which lead to corrosion in different kinds of iron pipe lines and properties expected from mediums for protection against corrosion are dealt with. Discussing metallic coatings author calls attention to Schoop metal spraying process with aid of which even recesses during the pipe installation will be covered. Properties of numerous non-metallic coatings are dealt with including "Herolith," an artificial resin and "Tornesit" a rubber containing product, which have been developed by the Mannesmann Röhren Werke. The latter also advanced a coating process of rapid galvanizing hard rubber. Methods and machines applying inner coatings for pipes and experiences gathered are discussed in another chapter. For protection and inner coating of water pipe lines already installed the electro-chemical Bücher-process has been developed. Increasing the corrosion resistance by adding alloying constituents, products as "Resistastahl" and "Patinastahl" of the Vereinigte Stahlwerke and "Cuprizettstahl" of the Friedrich Krupp A.G. are dealt with among others. Kz (4)

Evaluating Protective Coatings for Light Metals. J. L. McCloud. *Iron Age,* Vol. 129, Feb. 1932, pages 495-496. Gives results of study of the value of protective coatings over duralumin specimens of 0.12″ to 0.14″ thickness. The test specimens were quenched and aged, and had the following composition: Cu 4%; Mn 0.5%; Mg 0.5%; the remainder Al. Test bars are tested to determine tensile properties, strength and elongation. As pieces deteriorate in corrosive atmosphere, similar pieces are retested for same tensile properties and their properties plotted against time. The experiments made it possible to evaluate different coatings and to devise a coating system which gives suitable protection for light alloys over long periods of time. VSP (4)

Chemical Composition and Corrosion. H. Sutton. *Sheet Metal Industries,* Vol. 7, May 1933, pages 30-32. Extract from *Journal Institute of Metals,* Vol. 53, Part 3. Discusses the factors influencing corrosion. Deals with light metal alloys and corrosion resistant steels briefly. AWM (4)

Blade Erosion. F. J. Taylor. *Electrical Review,* Vol. 111, Dec. 23, 1932, page 916. Discusses the causes of cavitation in hydraulic turbine runners and proposals for remedying the evil. Cavitation will produce erosion only when accompanied by conditions which will cause concentration of the energy of the collapse of the H_2O vapor bubbles on a small proportion of the blade surface. Investigations by Elov. Englesson have shown the superiority of high-Cr cast-steel for turbine blading. MS (4)

The Corrosion of Metals. P. F. Thompson. *Proceedings Australasian Institute of Mining and Metallurgy,* No. 87, Sept. 30, 1932, pages 175-191. A general discussion. AHE (4)

Comparison of the Rusting Tendency of Lancashire Iron, Soft Martin and Electric Steels in Telegraph Wires. (Jämförande undersökning av rostningsbenägenheten hos lancashirejärn, mjukt martin- och electrostal med hängen till användning för telegraphtrad.) John Greger & Erik J. Virgin. *Jernkontorets Annaler,* Vol. 117, June 1933, pages 273-288. Open hearth and electric steels containing Cu showed greatest corrosion resistance; steels with low C content showed least. Lancashire and Armco iron fell between Cu steels and those of ordinary quality. Only Cu steel and Lancashire iron of low P content met the electric conductivity specifications. In salt spray the Cu steels showed the least corrosion resistance. HCD (4)

Controlling Nitric Acid Corrosion. RICHARD TULL. *Chemical Markets,* Vol. 32, Jan. 1933, pages 43-44. The well known resistance to corrosion and high temperature of both 18 Cr and 18-8 Cr-Ni steels have resulted in their extensive use. Austenitic Cr-Ni steels are not resistant over the entire range of nitric acid concentrations at all temperatures. However, they are practically unattacked in 30 to 70% concentrations of the boiling acid. Properties of each metal reviewed. RAW (4)

1

Scaling at Heat Treating Temperatures. CLAIR UPTHEGROVE. *Metal Progress,* Vol. 23, June 1933, pages 30-33. Results of further investigation of scaling than those described in Jan. *Metal Progress* are given. One temperature, 1700°F., and different mixtures of gases approximating the complex atmospheres of actual practice burning city gas in gas-air ratio of 1:5 to 1:1½ were used. Scaling loss curves for 5 plain C steels show scaling loss decreases with increasing CO up to 16%. The medium C steels show more tendency to scale than low and high C steels specially as CO decreases below 2%. With O_2 present the rate further increases from 0 to 1% O_2, falling off from 1 to 4%. Medium C steels showed the same tendency to scale more than low and high C steels with O_2. Curves of Murphy and Jominy's results on scaling at 2300° F. for the alloy steels are compared with the author's results on the same steels at 1700° F. Scaling loss for 1 hr. at 1700° is less than for 40 min. at 2300°. Losses are reduced 30% from no CO to 12% CO, 90% or more to 15% CO. 2% CO at 1700° is as protective as 16% at 2300°. 0.10 to 0.12% SO_2 further increases the scaling loss. The effects of other atmosphere constituents are related to the % of O_2 and CO present. A 6 lb. forging of 100 in.^{2} surface will scale 0.001" of thickness at 1700° in 2% CO, and 0.001" in 2% O_2. Total scale is more than the curves show because of heating up period in practice. Calling the loss double the forging above would scale 0.008" in O_2 compared with 0.002" in CO. Alloy and C steels show much the same scaling effects. WLC (4)

2

3

Remarkable Wear Effect Noted on a Ventilator Blade (Een merkwaardig kunstige slijtage van een waaierblad) F. W. VAN BERCKEL. *Polytechnisch Weekblad,* Vol. 26, Sept. 8, 1932, page 572. Macro-structure of a blade from a blower used in a transportation system for powdered coal exhibits the severe erosive action of this material. WH (4)

Modern Corrosion Resistant Pipes (Neuzeitliche korrosionssichere Rohre) VOLLMAR. *Gas und Wasserfach,* Vol. 76, July 22, 1933, pages 557-563. 3 methods of improving corrosion stability of pipes are considered: (1) treatment of H_2O, (2) improvement of metallic pipe material, (3) use of chemically resistant insulating materials. Cast iron pipes were improved by centrifugal casting instead of sand casting. Improvement of mechanical and corrosion properties is due to graphite being more homogenous and finer distributed in structure. In wrought Fe pipes impurities should be decreased to the greatest extent to suppress formation of local elements within the structure thus diminishing corrosion. This explains excellent properties of Armco Fe. Corrosion stability may be increased also by alloying. Patina steel with .2-.3% Cu is mentioned. GN (4)

4

Contribution to Theory of Tarnishing Process (Beitrag zur Theorie des Anlaufvorganges) C. WAGNER. *Zeitschrift für physikalische Chemie,* Abt. B, Vol. 21, Apr. 1933, pages 25-41. When heated in an atmosphere of O, S or halogens, a metal is usually covered with a dense film representing a compound of the metal and metalloid. In most cases, the diffusion in the film represents the time-determining factor. This diffusion takes place, at least partly, through the migration of ions and electrons. Under the assumption that no neutral atoms but ions and electrons are participating exclusively in the diffusion, the tarnishing velocity can be evaluated when taking affinity, conductivity and transference numbers of ions and electrons into account. The formulae derived are checked on the binary systems Ag-S and Cu-O and found to hold true. EF (4)

5

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Corrosion-Fatigue of Metals. T. S. FULLER, P. F. MUMMA & H. F. MOORE. *Preprint* No. 27, *American Society for Testing Materials,* June 1932, 4 pages; *Mechanical World & Engineering Record,* Vol. 92, Oct. 7, 1932, pages 341-342; *Iron & Steel Industry & British Foundryman,* Vol. 5, Sept. 1932, pages 435-436. A review of recent articles with the following summary: "Simultaneous cycles of repeated stress and corrosion by so mild an agent as fresh water may reduce the fatigue strength of a metal to a value below one-half its value for fatigue tests in air. Metals which are corrosion resistant under stressless conditions seem to be somewhat superior in their resistance to corrosion-fatigue, but are still markedly affected by a simultaneous repeated stress and corrosion. While there is very little 'time effect' in non-corrosive repeated stress the time of exposure to the corroding agent plays an important part in corrosion-fatigue. The mechanism of corrosion-fatigue seems to consist in the mechanical breaking down by repeated stress of the protective film of oxide which is found on nearly all metals, and consequent progressive spread of corrosion pits followed by the formation of a spreading fatigue crack. Certain inhibitors, notably sodium chromate, have been found effective in preventing corrosion-fatigue, probably by the rapid building up of a protective film counteracting tendency to break down the film locally by the action of cycles of repeated stress." VVK + Kz + CHL (4)

Studies in the Spontaneous Oxidation of Zinc and the Nature of "Pyrophoric" Zinc. W. S. SEBBORN. *Transactions Faraday Society,* Vol. 29, May 1933, pages 659-663; *Metal Industry,* London, Vol. 42, June 30, 1933, page 665. By "pyrophoric" Zn it is proposed to indicate Zn which undergoes spontaneous oxidation in the air, with incandescence. It has often been observed that when large masses of Zn dust have been used in reduction reactions and then left in a damp state after separation from the other reagents they become hot and oxidize and may even be a source of fire. No investigation of this phenomenon appears to have been recorded. When finely divided Zn, either the ordinary Zn or that prepared electrolytically, is moistened with 10% NaOH or KOH solution in the presence of air or O the excess moisture being removed by expression, a reaction takes place, considerable heat is evolved and the metal is oxidized to ZnO with incandescence. This phenomenon is not observed when the operation takes place in an inert atmosphere (N) or when solvents for ZnO and H other than KOH or NaOH are employed. Presence of small amounts of NaOH or KOH, moisture, and O is essential for the reaction to take place. Mechanism of reaction briefly follows: NaOH and KOH dissolve surface film of oxide and hydroxide from metallic Zn forming respective Na and K zincates. Combined effects of heat of this reaction and removal of protecting oxide from naturally reactive Zn causes further oxidation to take place: resultant new oxide film is again removed by caustic alkali, hence the reaction proceeds with acceleration, until temperature is sufficient to cause incandescence. Dilute acids also attack metal, liberating H which protects it from oxidation, while in case of ammonia and its salts, gaseous ammonia is always present, again protecting metal from oxidation by acting as an inert atmosphere. With Cd reaction takes place with much less vigor. With Al no effects such as those described are observed in spite of its great affinity for O. Ha + WAT (4)

Effect of Hydrogen-Ion Concentration on Corrosion by Feed-water. S. E. TRAY. *Mechanical World & Engineering Record,* Vol. 92, July 15, 1932, pages 51-52. Pure water contains ions of H and OH making it alkaline or acid. The pH value of a sample of water is a measure of the velocity of corrosion, although the O content determines corrosion quantitatively. Corrosion can be reduced by controlling the pH value. Kz (4)

Faulty Location of Boiler Water Feed Pipes Causes Boiler Defects (Fehlerhafte Einführung der Speiseleitung verursacht Kesselschäden) H. TÜRKE. *Die Wärme,* Vol. 58, Mar. 18, 1933, pages 173-174. Corrosion defects were found in a double flue boiler but only restricted to the left corrugated flue behind the bridge wall. The original wall thickness of 6 mm. was partly reduced to 1 mm. The right flue did not exhibit any corrosion damages. The source of trouble is ascribed to the feed pipe which enters the Lancashire boiler directly above the left flue and follows it about 1000 mm. behind the bridge. Incrustations from the feed water preheated to 75° C. clogged the feed pipe and only entered the boiler at the end of the pipe. Due to the large temperature gradient between feed water and flue wall, severe corrosion took place at this spot. The damage was remedied by cutting out the defective metal and electrically welding on of a patch. The seam of 5.35 m. total length was heated to 600° C. by charcoal baskets to relieve welding stresses. The originally horizontal feed pipe was replaced by a vertical one. EF (4)

Chemical Embrittlement of Boiler Plates. L. W. SCHUSTER. *Iron & Coal Trades Review,* Vol. 126, May 12, 1933, page 740. Failures of boiler plates under stress can often be ascribed to chemical attack leading to intergranular cracking or embrittlement. This can take place only below the water level. The particular features of intergranular cracks can be summarized as follows: the usual crack in a boiler plate is cross-granular, and some abnormal condition must exist when the plate has been overstressed either by faulty construction or excessive riveting pressure. A network of intergranular cracks borders the main line of fracture, a dark oxide scale is usually found near the cracks, sometimes also white deposits as an indication of an alkaline reaction. This type of failure can be easily imitated in the laboratory by immersing a stressed specimen in boiling caustic soda when it breaks after a few days with intergranular fracture. Aging seems to have little to do with this phenomenon. The term "chemical embrittlement" is identical with the American expression "caustic embrittlement." Ha (4)

Rust Proof and Aging Resistant Steels (Über schwachrostende und alterungsbeständige Stähle) RESPEK. *Maschinenkonstrukteur-Betriebstechnik,* Vol. 66, June 10, 1933, pages 83-84. Discusses properties of Izett and Cuprizett steel (.25-.50% Cu) distinguished by small tendency to aging and corrosion. Besides high resistance to corrosion Cuprizett steel possesses the favorable properties of Izett steel. GN (4)

Cylinder Wear in Diesel Engines. H. R. RICARDO. *Mechanical World & Engineering Record,* Vol. 93, Mar. 31, 1933, pages 310-312. Materials such as case-hardened or nitrogen-hardened steel, which are known to resist abrasion were found more worn than cast iron. Considerations of this kind are called sufficient to doubt that liner wear is to be accounted for by abrasion as the major factor. The author raises the question whether corrosion is the chief factor in cylinder wear and mentions that cast-irons with high Cr and high S content are more wear resistant. Kz (4)

Corrosion, the Billion Dollar Thief. I. Introduction, Definition, History and Elementary Concepts. FREDERICK A. ROHRMAN. *Journal of Chemical Education,* Vol. 10, Mar. 1933, pages 141-147. Economic importance, history, definition, and elementary fundamentals of subject are presented. All corrosion is shown to be result of cell action, i.e., action of 2 different elements in presence of an electrolyte. Importance of Nernst equation and H overvoltage is stressed. Recent work of Palmaer on "Induction period" is outlined and its importance demonstrated. GTM (4)

The Problem of the Water-Cooled Piston Rod in Two-Stroke Cycle Double-Acting Oil Engines. S. F. DOREY. *Institution of Naval Architects,* Spring Meeting, 1933, Advance Copy, 18 pages. This paper which will be published in Transactions of the Institution with discussion deals with failure of piston rods due to fatigue stress and corrosion in two-stroke double-acting oil engines and recommend lining of such rods with a sleeve of stainless iron, stainless steel or cupro-nickel alloys, so that no part of the steel rod comes in contact with the cooling water. Experiments have also shown possibility of using carefully selected nitrided steel, or of adding liquid inhibitors such as potassium chromate to cooling water. Use of electro-deposited Cd, Cr, or Ni is not recommended as such deposits have not been developed to a state to justify adequate protection against corrosion. JWD (4)

STRUCTURE OF METALS & ALLOYS (5)

Metallography & Macrography (5a)

Atomic Increase in Resistance of Gold, Silver and Copper Alloys. (Die atomaren Widerstandserhöhungen der verdünnten Gold-, Silber- und Kupfer-Legierungen.) J. O. LINDE. *Metallwirtschaft,* Vol. 12, Mar. 31, 1933, pages 173-175. Electrical resistance of solid solution alloys of Au, Ag and Cu with various elements at various temperatures was determined. Results are given in tables and graphs. Resistance increases with increase in atomic % of addition element and it is usually a straight line relation. Rule of Norbury, that atomic increase in resistance is larger the greater the horizontal distance of alloying element from base element in periodic system is, was found to be correct only for alloys with *b* elements and not with *a* elements. Relation between these facts and atomic structure of alloying elements is discussed. Increase in resistance of alloys of Cu with *a* elements is larger than that of Au and Ag with *a* elements, but reverse is case in alloys with *b* elements, with exception of Hg alloys. Variation of resistance due to change in temperature is usually quite small. In *b* element alloys increase in resistance is usually smaller with decreasing temperature, while in *a* element alloys it is usually larger with decreasing temperature. Resistance temperature curve of Au containing 7.8 atomic % Cr is of same type as Konstantan and Manganin. Resistance measurements added to information on solubility of various alloys. 10 references. CEM (5a)

Ternary System Silver-Copper-Phosphorus. (Das Dreistoffsystem Silber-Kupfer-Phosphor.) H. MOSER, K. W. FRÖLICH & E. RAUB. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 208, Oct. 1932, pages 225-237. Binary systems Cu-P and Ag-P are first reviewed and then ternary alloy with a ratio of Cu: P = 3:1 and higher and less than 3:1 investigated with regard to how the addition of the third component changes the existing formation of solid solutions. For the ratio 3:1 a eutectic at 796-797° C. was found to consist of 46.2% Ag, 46.3% Cu, 7.5% P, which is 53.8% Cu_3P. The eutectic point for Cu:P $>$ 3:1 is at 646 $\pm$ 1° C. with a composition of 17.9% Ag, 30.4% Cu and 51.7% Cu_3P; for Cu:P $<$ 3:1 it is at 703° C. and the composition is 41.6% Cu_3P, 44.9% Ag, 13.4% AgP_2. Ha (5a)

Gold-Manganese System. (Ueber das System Mangan-Gold.) H. MOSER, E. RAUB & E. VINCKE. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 210, Jan. 1933, pages 67-76. Constitutional diagram was investigated over the whole range from 100% Au to 100% Mn. The eutectic is found at 44% Mn at 1073° C. 3 transformations were observed in solid state of which 2 are due to transformations of Mn, and 3rd occurs in Au-rich solid solutions between 5 and 15% Mn; all transformations are connected with strong heat effects. Diagrams and microphotographs show structural changes. Ha (5a)

Alloys of Iron, Manganese and Carbon. Microscopic Studies of Binary Iron-Manganese Alloys. V. N. KRIVOBOK & CYRIL WELLS. *Mining & Metalllurgical Investigations Carnegie Institute of Technology, Mining & Metallurgical Advisory Boards,* 6th Open Meeting, Oct. 28, 1932, 2 pages. This paper treats in general the same subject as paper by Walters (*Metals & Alloys,* Vol. 4, Nov. 1933, page MA 346) showing in addition photomicrographs of the transformations of the α-, γ- and ϵ-phases at different temperatures and different contents of Mn. Ha (5a)

Observations on the "Bitter's lines" of an Iron-Silicon Sheet. (Beobachtungen an den Bitterschen Streifen bei einem Eisen-Siliciumblech.) R. BECKER & H. F. W. FREUNDLICH. *Zeitschrift für Physik,* Vol. 80, Feb. 1933, pages 292-298. After deposition of an almost colloidal suspension of Fe_2O_3 particles on large crystal Si-Fe, there results, on moderate magnetization, a striation. As saturation is approached, the grain boundaries and the differences in the precipitated pattern disappear and there remains only a merged striation that is perpendicular to the applied field. RRS (5a)

Determination of Linear Transformation Velocity of Austenite into Pearlite. (Zur Bestimmung der linearen Umwandlungsgeschwindigkeit des Austenits in Perlit.) A. A. BOTSCHWAR. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 210, Jan. 1933, pages 168-170. A measuring method was developed by which the transformation point Ar can be observed directly with the dilatometer by means of a comparison substance, and the time of the transformation determined. Ha (5a)

Arsenic in Lead Bearing Metals. (Über das Arsen in Bleilagermetallen.) *Zeitschrift für Metallkunde,* Vol. 24, Dec. 1932, pages 306-308. Structure of bearing metals constituted of Pb-Sn alloys with As up to 10% is briefly discussed. Brinell hardness numbers and impact test values are given for a series of Pb-Sn-As, and also a series of Pb-Sn-Sb-As alloys. Alloys with more than 1% As are harder and possess greater compressive strength but are of diminished toughness; these are useful for bearings with high bearing pressure free from impact. RFM (5a)

Method for the Quantitative Investigation of the Rolling Texture. (Ueber eine quantitative Untersuchung der Walztextur.) N. AKULOV & N. BRUECHATOV. *Annalen der Physik,* Series 5, Vol. 15, Dec. 1932, pages 741-749. Authors developed a method based on relation between lattice structure and magnetization curve to determine quantitatively amount of deformation and distribution of crystals in rolled iron sheets. A numerical example illustrates the procedure. Ha (5a)

Complicated Magnetic Structure of Ferromagnetic Monocrystals. (Ueber die komplizierte magnetische Struktur der ferro-magnetischen Einkristalle.) N. AKULOV & M. DEGTIAR. *Annalen der Physik,* Series 5, Vol. 15, Dec. 1932, pages 750-756. By applying a fine magnetic powder (Fe_2O_3) on polished surface of a monocrystal the slidelines and S-lines can clearly be observed under a microscope while etching does not always show them. The S-lines are 2 systems of lines parallel to the axis of slight magnetization which are not revealed by etching. Ha (5a)

Contribution to the Study of Inclusions in Steels. A. M. PORTEVIN & R. PERRIN. *Iron & Steel Institute, Advance Copy* No. 11, May 1933, 20 pages; *Revue de Metallurgie,* Vol. 30, May 1933, pages 175-187. Principal cause of differences of "quality" in steels may be attributed to inclusions. It is of importance to know both the composition and the structure of inclusions. Equilibria in which inclusions are formed are discussed from the point of view of the phase rule. In deoxidizing with Mn and Si it is important to add these elements in such a ratio that the slag in equilibrium with the residual Mn and Si in the metal will fuse at a low temperature. The slag formed on the addition of these 2 elements does not necessarily contain Mn and Si in the ratios as they were added. JDG + JLG (5a)

Manganese-Nickel Alloys. (Sur les alliages manganèse-nickel.) A. DOURDINE. *Revue de Métallurgie,* Vol. 29, Oct. 1932, pages 507-518; Nov. 1932, pages 565-573. Results of experimental work conducted in 1912. Ni-Mn alloys crystallize on usual cooling both in stable and unstable state. The unstable state is limited by the range 43.2-58.5% Mn. Unstable alloys form a continuous series of solid solutions with a probable exception near pure Mn. They can be converted into the stable state by proper heating near solidus. In the stable state the series of solid solutions is interrupted by 2 heterogeneous regions, 43.2-48.37% Mn and 49-58.5% Mn. Three intermetallic compounds were observed. MnNi which corresponds to delta phase is hard and brittle. It has a strong resistance to acids and a characteristic structure. $Mn_3 Ni_2$, gamma phase, is very easily attacked by acids and has physical properties resembling those of Ni. Beta phase, Mn_3Ni_4, located on Ni side of equilibrium diagram, has properties intermediate between the two former. A constitutional diagram is given. JDG (5a)

Influence of Third Metals Upon the Constitution of the Brasses. V. The Influence of Manganese. (Der Einfluss von dritten Metallen auf die Konstitution der Messinglegierungen. V. Der Einfluss von Mangan.) O. BAUER & M. HANSEN. *Zeitschrift für Metallkunde,* Vol. 25, Jan. 1933, pages 17-22. See *Zeitschrift für Metallkunde,* Vol. 24, Jan. 1932, pages 1-6. Previous literature is reviewed. The constitution of alloys in the composition ranges 70 to 50% Cu and 0 to 6% Mn was studied by thermal analysis and micrographic observations of structure, for the sections of the ternary alloys at 0.53, 1.26, 2.24, 4.20, and 5.78% Mn. The freezing of these ternary alloys is similar to that of Cu-Zn alloys. The peritectic reaction α + melt = β occurs in a very narrow temperature interval; the peritectic temperature is lowered by Mn from 905° to 860° at 5.5 to 7% Mn (according to Cu content). The duplex field ($\alpha + \beta$) is displaced by Mn towards Cu-poor alloys. Alloys containing the β phase also contain, at 4-4.7% Mn and below 375°, an Mn-rich phase owing to the decreasing solubility of Mn in β-brass with decreasing temperature. The article is illustrated by ternary and sections of the ternary system, and also by photomicrographs. RFM (5a)

Structure of Some Ternary Eutectics. (Zur Struktur einiger ternarer Eutektika.) A. A. BOTSCHWAR & K. W. GOREW. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 210, Jan. 1933, pages 171-172. Experiments showed that 3 types of crystals in a ternary eutectic have often a regular arrangement and are not irregularly distributed; the component with the greatest number of crystallization centers crystallizes first, then the second component is precipitated on the first and finally the third component on the second. The table gives the composition and eutectic temperatures of several eutectics:

Eutectic	Pb	Sn	Cd	Bi	° C.
Pb-Cd-Bi	40.2	....	8.1	51.6	91.5
Cd-Sn-Bi	....	26	20	54	103
Pb-Sn-Cd	32	50	18	....	145

Ha (5a)

The Surface Energy of Iron Carbide. YAP, CHU-PHAY. *Transactions American Society for Steel Treating,* Vol. 20, Oct. 1932, pages 289-313. Previously abstracted as Preprint No. 10, 1931. See *Metals & Alloys,* Vol. 3, Mar. 1933, page MA 58. WLC (5a)

Structural Changes in Hypo-Eutectoid Steels on Heating. H. C. H. CARPENTER & J. M. ROBERTSON. *Iron & Steel Institute, Advance Copy* No. 2, May 1933, 26 pages. Carbon steels containing from 0.10 to 0.81% C were used. All samples were first heated to 1050° C. in a vacuum. They were then reheated in such a manner that one end of the sample was at 1000° C. while the other was at 600° C. Samples heated for different lengths of time and cooled with different rates were sectioned longitudinally and their microstructures studied. On heating through A_{c1}, pearlite is converted into fine-grained austenite. When held just above A_{c1}, the austenitic grains remain small. At higher temperatures both large and small grains are formed, and at still higher temperatures only large grains are found. Steels containing from 0.2 to 0.6% C behaved in the same manner on heating. In steel containing 0.1% C, small austenite grains were formed by heating just above A_{c1}, but small ferrite grains were not obtained on slow cooling. A banded structure could be produced in some steels at will. Repeated heating to a temperature just above the critical range did not produce a progressive decrease in grain size. 5 references. JLG (5a)

Automobile Sheet Steel. W. F. MCGARRITY & H. V. ANDERSON. *Metal Stampings,* Vol. 5, Jan. 1932, pages 58-59. Abstract of paper read before the American Society for Steel Treating. See "Effect of Normalizing on the Grain Structure and Physical Properties of Automobile Sheet Steel," *Metals & Alloys,* Vol. 3, May 1932, page MA 124. MS (5a)

The Equilibrium Diagram of the Binary System of Antimony and Manganese. TAKEJIRO MURAKAMI & ATSUYOSHI HATTA. *Kinzoku- no- Kenkyu,* Vol. 9, Nov. 1932, pages 465-475. Equilibrium diagram of Sb-Mn system has been investigated by means of thermal analysis, electrical resistance measurement and microscopic examination. Equilibrium diagram obtained by present authors shown. In this system there exist 3 intermetallic phases, η (MnSb), ϵ (Mn_3Sb_2) and δ (Mn_2Sb). η phase has practically no solubility range and forms a eutectic with Sb, at 570° C. 9.5% Mn. ϵ phase is formed by a peritectic reaction, melt $+ \delta \rightleftharpoons \epsilon$, at 872° C., existing range being 32-41% Mn. δ phase exists in 45-50% Mn at high temperature, but in 47-48% Mn at room temperature. δ phase forms a eutectic with β phase (Mn) at 922° C., 55% Mn. β phase is produced by a peritectic reaction, melt $+ \gamma \rightleftharpoons \beta$, at 1202° C. On further cooling β phase is resolved into α (Mn) and δ phases at 677° C., 94.5% Mn by a eutectic reaction, β (Mn) $\rightleftharpoons \alpha$ (Mn) $+ \delta$. TM (5a)

Study of the α-Phase of the System Lead-Magnesium. N. S. KURNAKOW, S. A. POGODIN & T. A. VIDUSOVA. *Izvestia Instituta Fiziko-Khimicheskogo Analiza,* Vol. 6, 1933, pages 266-267. Hardness measurements showed the existence of the solid solution of the Mg in Pb. The limit of solid solubility is 245° C.-0.7% Mg, at 220° C.-0.5% Mg, at 150° C.-0.3% Mg and at room temperature less than 0.2% Mg. These alloys showed the age-hardening effect. The hardness curve intersects the ordinate of the chemical compound $PbMg_2$. In practice the addition of 0.5-0.7% Mg to Pb is advantageous. NA (5a)

Study of the Phases α and β of the System Sodium-Lead. N. S. KURNAKOW & S. A. POGODIN. *Izvestia Instituta Fiziko-Khimicheskogo Analiza,* Vol. 6, 1933, page 275. Investigation of the system Pb-Na in the range from 0 to 6.41% Na, by thermal analysis, hardness and electrical resistance measurement was carried out. The limit of the solubility of Na in solid Pb reaches 1.9% at the eutectic temperature and is only 0.4% at 20° C. The Na-Pb alloys showed very marked age-hardening effects. At the compositions 3.5-5.5% Na is the phase of variable composition (β-phase), which is not the compound Na_2Pb_5 as previously pointed out by another investigator. NA (5a)

Ternary Alloys of Thallium with Lead, Cadmium and Tin. N. S. KURNAKOW & N. I. KORENEW. *Izvestia Instituta Fiziko-Khimicheskogo Analiza,* Vol. 6, 1933, pages 47-68. The ternary alloys of Tl-Pb-Cd and Tl-Pb-Sn were studied from the viewpoint of the elucidation of the nature of the α-phase of the system Tl-Pb. The investigation was carried out by thermal analysis. The maximum point on the liquidus of the constitutional diagram of the Tl-Pb alloys has been displaced and changes its composition with changing the factor of equilibrium (addition of the third component). The electrical conductivity is changed very slightly by addition of 1% Cd and 5% Sn. The eutectic lines of the systems Pb-Tl-Cd and Pb-Tl-Sn are displaced from the straight lines joining the binary eutectics of the binary systems Pb-Cd with Tl-Cd and Pb-Sn with Tl-Sn. The existence of the compound $PbTl_2$ is not confirmed by the present investigation. The maximum on the liquidus curve corresponds to the solid solution of Tl in Pb. NA (5a)

Polishing Metallographic Specimens of Cast Iron. Correspondence from NEIL A. MOORE. *Metals & Alloys,* Vol. 4, Apr. 1933, page 44. The quick preparation of cast Fe metallographic specimens is described. The improvement over old methods is illustrated by 4 micrographs. WLC (5a)

Phosphide Eutectic in Cast Iron. (Ueber das Phosphideutektikum im Gusseisen.) R. MITSCHE. *Die Giesserei,* Vol. 19, Dec. 9, 1932, pages 497-499. An etching agent consisting of 20 g. $K_3Fe\ (CN)_6$, 10 g. NaOH, 100 g. H_2O, and applied cold, clearly reveals carbide and phosphide in iron as it attacks both differently. Examples are shown. Ha (5a)

Influence of Annealing Temperature on Form of Precipitated Graphite. (Influence de la Température de Recuit sur la Forme du Graphite Precipité.) AUGUSTE LE-THOMAS & RENEE LEROMANCER. *Bulletin de l'Association Technique de Fonderie,* Vol. 16, Sept. 1932 (supplement), pages 18-19. Paper presented at World Foundry Congress, Paris, Sept. 1932. A white cast iron gave nodular graphite when annealed at temperatures below 900° C. and lamellar graphite at higher annealing temperatures. A dilatometric study of this iron gave 975° C. as temperature of graphitization. 2 references. WHS (5a)

The Cobalt-Tungsten System. W. P. Sykes. *Transactions American Society for Steel Treating,* Vol. 21, May 1933, pages 385-423. Paper presented at Buffalo Convention, Oct. 1932. Tentative constitutional diagram of system Co-W has been constructed from microstructure, X-ray diffraction pattern, resistance and melting point data. Co dissolves some 35% W at 1465° C., the temperature of the eutectic. Solid solubility decreases to about 3% W at 550° C. The complete eutectic occurs at a composition near 46% W and consists of the Co-rich solid solution (β) plus an intermediate phase (δ) represented by the formula WCo (75.7% W). This latter phase is formed upon cooling by a peritectic reaction between the W-rich solid solution (dissolving 0.2-0.3% Co) and the Co-rich liquid. A second intermediate phase (ϵ) forms at 1100° C. as the result of a peritectoid reaction between (δ) and the Co-rich solid solution (β). It approximates in composition the formula Co_7W_2 (47.1% W). The Co-rich solid solutions are subject to age-hardening at temperatures above 500° C. A maximum hardness of Rockwell C 65 has been observed as the result of aging at 600° C. for 200 hours a rolled alloy containing 35% W. The hardness developed by aging is unusually persistent at temperatures as high as 700° to 750° C. Electrical resistivity measurements for some Co-W alloys are given. Density of Co metal after various treatments is tabulated. Includes discussion. 9 references. WLC (5a)

Grain Measurements by Commercial Compression Tests. (Kornmessungen an technischen Druckproben.) W. Tafel & W. Waschek. *Metallwirtschaft,* Vol. 12, Aug. 4, 1933, pages 445-447; Aug. 11, 1933, pages 460-463. It is assumed that approximately spherical grains in a crystalline metal become ellipsoids when deformed by compression. After sectioning an object in two planes perpendicular to one another before and after deformation the diameters of the crystals are measured at a magnification of 200 X. Simplified formulas are given for the calculation of average crystal deformation from these measurements. The results of measurements made on annealed .05 C steel cylinders are given which were compressed 20, 35, 50 and 70%. The deformation increases slightly from the rim to the axis of the cylinders, reaching a maximum near, but not quite at the axis. At 20 and 35% total deformation the average crystal deformation measured at the middle of the cylinder is greater than the total deformation. At 50% they are approximately the same, and at 70% the total deformation is greater. The variation of deformation at different heights in a cylinder was also determined. 14 references. CEM (5a)

Detection of Small Amounts of Eutectics in Metals by Determination of Tensile Strength in Dependence upon Temperature. (Über den Nachweis geringer Mengen von Eutektikum in Metallen durch Bestimmung der Zugfestigkeit in Abhängigkeit von der Temperatur.) G. Tammann & H. J. Rocha. *Zeitschrift für Metallkunde,* Vol. 25, June 1933, pages 133-134. Samples of alloys in strip form are loaded at various loads and heated until fracture obtains. The presence of molten eutectic is shown on the temperature-load curve by a straight portion at constant temperature; this temperature corresponds to the eutectic temperature. Samples containing no eutectic give a smooth curve. Quantities of eutectic as small as 0.037% (Zn + 0.1% Sn) can be detected, and the method is thus more sensitive than the microscopic. Temperature-load curves are shown for alloys of Zn, Zn + 0.1% Sn, + 1% Sn, Cd, Cd + 0.05% Pb, + 0.1% Pb. Fe with 0.5% FeS shows a sharp break at 980°, corresponding to the eutectic temperature. The position of solidus temperatures may be detected in the same way; examples are shown for alloys of Ag + 9% Cu, and + 5% Cu. RFM (5a)

A Thermodynamic Study of the Iron Carbon Diagram. J. B. Austin. *Metals & Alloys,* Vol. 4, Apr. 1933, pages 49-54. An abstract of a paper by Fredrich Körber and Willy Oelson. *Archiv für das Eisenhüttenwesen,* Vol. 5, 1931, pages 569-578. 7 references. Application of thermodynamics to Fe-C diagram is discussed with notations and conventions used in this country substituted for the original. A bibliography is included of the historical development of the Fe-C diagram and for the individual phases of the system which are plotted on an Fe-C diagram. WLC (5a)

Slow Graphitization at Moderate Temperatures. (Les Graphitisations Lentes aux Températures Modérées.) Auguste LeThomas & Ernest Morlet. *Bulletin de l'Association Technique de Fonderie,* Vol. 16, Sept. 1932 (supplement), pages 19-23. Paper presented at World Foundry Congress, Paris, Sept. 1932. Cast iron studied had following composition: C 3.50%, Si 1.57%, Mn 0.71%, S 0.10%, P 0.56%. Dilatometric study showed limit of reversibility of iron to be 690° C. But long treatment at lower temperature gave changes in iron. There is no temperature below which graphitization can be said to be absolutely nonexistent. 4 references. WHS (5a)

Material Testing at the Foundry Exhibition (Werkstoffprüfung auf der Giesserei-Messe) Joh. Mehrtens. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 54, June 11, 1933, pages 247-248. Description of microscopes exhibited. Discussion of advantages derived from metallographic examinations. GN (5a)

Relating the Chemical Composition to the Micro-structure of a Complex Brass. Wesley Lambert. *Metallurgia,* Vol. 8, July 1933, pages 83-84. Explains application of Guillet's coefficients for estimating amounts of α and β phases in brass. JLG (5a)

Transformation Kinetics of Ausfenite (Zur Umwandlungskinetik des Austenits) H. Lange & F. Wever. *Die Naturwissenschaften,* Vol. 21, May 26, 1933, pages 389-391. Cr-Ni steels are quenched at certain temperatures and changes checked by magnetometer and dilatometer. Three different temperature ranges were established in which the transformation of the austenite takes place according to entirely different laws and results. (See also *Mitteilungen des Kaiser Wilhelm Instituts für Eisenforschung,* Vol. 14, Nos. 71 and 85, 1932.) The formerly applied testing method was employed for new tests on Cr-Ni steels of different compositions which corroborated the 3 transition ranges previously found. In the upper transformation range (up to 500° C.) a carbide is formed which shows no Curie point. In the medium range a carbide forms below 300° C. which changes at 200° C. into a ferro-magnetic form similar to Fe_3C of the ordinary plain C steels. Temperature-magnetization curves of an 0.48 C, 2.0 Cr and 3.2 Ni steel are presented. The carbide formed at high temperatures comprises practically all the Cr present in the steel explaining the absence of the Curie point and pointing to largely prevailing diffusion occurrences at these elevated temperatures. Martensite formation always starts at the same temperature regardless of the cooling rate and is quickly checked when the temperature is held constant. The amount of austenite formed depends solely on the temperature and is completed at the absolute zero point. The striking coincidence of the theoretical magnetization curve of α-Fe with the curve of the martensite content is pointed out. EF (5a)

Solubility Experiments with Gold-Silver-Monocrystals. (Lösungsversuche mit Gold-Silbereinkristallen.) E. Schmidt. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 212, June 20, 1933, pages 415-419. The influence of crystal orientation on solubility was found to be negligible, the concentration of the alloys is determining for the velocity of dissolution. Test results are tabulated and method of investigation is described. Ha (5a)

Polishing and Etching of Constituents of Aluminum Alloys. F. Keller & G. W. Wilcox. *Metal Progress,* Vol. 23, Apr. 1933, pages 44-46. A large data sheet for the identification of constituents of Al alloys is an important part of this article. It is based on that by Dix and Keith with additions. Some of the constituents, as $CuAl_2$, Si, Mg_2Si, and beta Al-Mg, are easily identified as polished. Others require etching. The constituents are: elements that do not form compounds with Al and are present in the primary state, elements that form compounds with Al, compounds formed by 2 or more elements other than Al and which are stable in Al, ternary or complex compounds. The polishing method and 6 generally used etching reagents and their use are described. Methods of identification and a set of 20 standard specimens with their analyses are described. WLC (5a)

Some Observations Concerning the Widmanstätten Structure and Its Formation in Hypo-eutectoid Steels. A. P. Terrile. *Transactions American Society for Steel Treating,* Vol. 21, July 1933, pages 613-622. 4 references. Previous work on this subject is discussed. The theory of the methods used by Belaiew and Krivobok, which differed mainly in cooling through the secondary zone, to achieve the same structure are discussed. The author's experiments were conducted on identical samples of S.A.E. 1040 and 1050 steels. Size, analysis, and treatment, are given in a table. The treatment varied principally in the cooling rates in the granulation and secondary zones. Micrographs after each treatment are given. The rate of cooling through the granulation zone has a marked influence on the development of Widmanstätten structure. The persistence of network type structures in re-heated steels, furnace cooled, is largely due to the differential cooling of the charge and furnace. The rapid cooling of the charge at first suppresses the Ar_3, but controlled cooling through the granulation zone overcomes this suppression. Widmanstätten structure was developed from only 1800° F. by close control of the cooling rate through the granulation zone. Cooling rate through the secondary zone is an important factor on the extent of ferrite crystallization and coalescence. Development of the structure in ferritic hypoeutectoid steels depends on treatment to avoid excessive ferrite crystallization and agglomeration. Widmanstätten structure was easily produced in 1025 steel by air or furnace cooling from high heat. The practical value of these experiments in the development of annealing cycles is pointed out. WLC (5a)

The Effect of Carbon on the Change Occurring by Heating High Manganese Austenitic Steel. Takejiro Murakami & Tadakazu Yajima. *Tetsu to Hagane,* Vol. 19, Jan. 1933, pages 28-36. High Mn steels, about 13%, and varying C 0.28-1.46% were quenched from high temperature; by heating these steels to several temperatures, the changes in microstructure, magnetization and hardness were studied, and the effect of C on these changes was thoroughly illustrated. In microstructure, the separation of carbide and the changes, austenite $\longrightarrow$ martensite, and austenite $\longrightarrow$ troostite, take place by heating. Acicular carbide separates in hypereutectoid steels, the amount being increased with increasing C content. As the temperature rises up to 450° C. the amount of carbide increases, after which it decreases, owing to increase of the solubility of C in austenite. The changes, austenite $\longrightarrow$ martensite, and austenite $\longrightarrow$ troostite (modulus), take place more readily, as the C content increases. The rate of these changes and the amount of the product are maximum at 550°. The former change gradually proceeds and is not complete even after heating for 50 hours, while the latter change is nearly complete on heating at temperatures above 500° for several hours. The intensity of magnetization increases by heating, the rate being sluggish in low C specimens. The intensity is, therefore, less in low C specimens, though it exceeds that in high C specimens, by a prolonged heating, when the heating temperature is below 500°. The hardness also increases by heating, the rate being large in high C specimens. The increase is marked at the initial stage of heating and somewhat decreases by further heating. In a low C specimen with 0.28%, h-phase is formed, the martensite being increased. In this specimen, there is great increase of magnetization on heating, but small increase of hardness. TM (5a)

Influence of Temperature upon the Diffusion Velocity of Solid Metals. Chujiro Matano. *Memoirs College of Science, Kyoto Imperial University,* May 1932, (A) 15, 167-180. The ratio of velocities of diffusion given by Weiss is equal to the ratio of coefficients of diffusion defined by Fick's law in the case of solid solution. The Zn-Cu system being taken as an example it is shown by means of an electrical resistance method that the relation between the velocity of diffusion V and the absolute temperature T is given by $V = Be^{-\frac{\alpha}{T}}$ instead of Weiss' formula $V = Ke^{\beta T}$ in the range of temperature 87°-302° C., where B, K, α and β are constants and $\alpha = 9.52 \times 10^3$ degrees. HN (5a)

Transformation of Gamma into Alpha Iron Near Room Temperature. (Über die Umwandlung des gamma in alpha-Eisens in der Nähe der Raumtemperatur.) E. Scheil. *Die Metallbörse,* Vol. 22, July 9, 1932, page 867. The $\gamma \longrightarrow \alpha$ transformation occurs with great velocity independent of temperature. The beginning is not shifted due to increasing cooling velocities. The beginning of the conversion and the amount of the transformed γ Fe increase with increasing stresses. The decrease of the elastic modulus near the transformation point indicates a physically instable state in γ-Fe. Plastic deformation near the beginning of the transformation precipitates the conversion while at 50°-100° C. above this temperature only gliding in the γ crystals is noticed. Paper at the 37 General Meeting of the Deutsche Bunsengesellschaft für angewandte physikalische Chemie. EF (5a)

Interpretation of Plasticity in Single Crystals. (Zur Deutung der Plastizität in Einkristallen.) H. Schlechtweg. *Physikalische Zeitschrift,* Vol. 34, May 15, 1933, pages 404-407. Writer dismisses an interpretation based on the assumption of a mosaic structure. He shows why gliding starts at the ends of a flat test rod. Interpretations confirm previous work of Polanyi (*Die Naturwissenschaften,* Vol. 16, 1928, page 285) with Prandtl's kinetic theory of solid bodies. (*Zeitschrift für angewandte Mathematik & Mechanik,* Vol. 8, 1928, page 85.) Further derivations on steel are announced. EF (5a)

Aluminum Constituents. F. Keller & G. W. Wilcox. *Metal Progress,* Vol. 23, May 1933, pages 38, 40, 42, 44, 46, 48, 50. Micrographs of the structures of Al alloys are published showing various constituents of such alloys and their reactions to various etchants. WLC (5a)

Influence of Ni and Si on the Miscibility Gap of the Fe-Cu System in Solid State (20°C.). [Beiträge zum Einfluss des Ni und Si auf die Mischungslücke des Fe-Cu-Systems im festen Zustand (20°C.).] F. Roll. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 212, May 1933, pages 61-64. The miscibility gap which exists in the Fe corner of the ternary systems Fe-Cu-Ni and Fe-Cu-Si was investigated. The gap reduces with increasing Ni considerably more than with increasing Si. 15 references. Ha (5a)

Recrystallization Phenomena on Synthetic Metallic Bodies. (Rekristallisationserscheinungen an synthetischen Metallkörpern.) F. Sauerwald. *Die Naturwissenschaften,* Vol. 21, June 16, 1933, page 467. Referring to a previous communication of W. Trzebiatowski (*Die Naturwissenschaften,* Vol. 21, Mar. 10, 1933, page 205). The author denies that the new experimental data are in disagreement with his own previous determinations regarding the hardness loss and change of the Debye interference lines on rising annealing temperatures. Some new results in this field will be published soon. EF (5a)

Classical and Atomistic Metallography. Albert Portevin. *Metal Progress,* Vol. 23, Jan. 1933, pages 45-46. The difference between classical and atomistic metallography is discussed. Classical metallography is that in daily use which explains the phenomena and variations in properties of metals and alloys, allowing their judicious use. Atomistic metallography goes to the nature of the constituents, nearer to the origin of properties and in the future may enable a metallurgist to build alloys of predetermined properties by assembling the atoms into desirable crystals and grains. WLC (5a)

Electro-chemical Investigation of Cd-Ag Alloys. (Eine elektrochemische Untersuchung von Cadmium-Silber Legierungen.) A. Ölander. *Zeitschrift für physikalische Chemie,* Abt. A, Vol. 163, Jan. 1933, pages 107-121. The electrode potentials of Ag-Cd alloys were measured at elevated temperatures leading to a modification of the constitutional diagram formerly established. (Fraenkel & Wolf, *Zeitschrift für anorganische Chemie,* Vol. 189, Apr. 22, 1930, pages 145-167.) A new transformation γ-δ was discovered and the conversion β'-β previously known, was investigated more thoroughly. The transformation heats are evaluated. The β' and γ-phases exhibit a definite atomic structure and deviations from the ideal arrangement are estimated. EF (5a)

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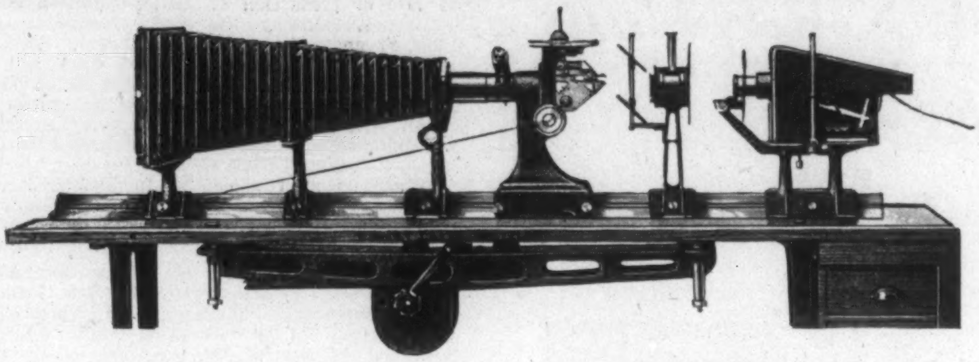

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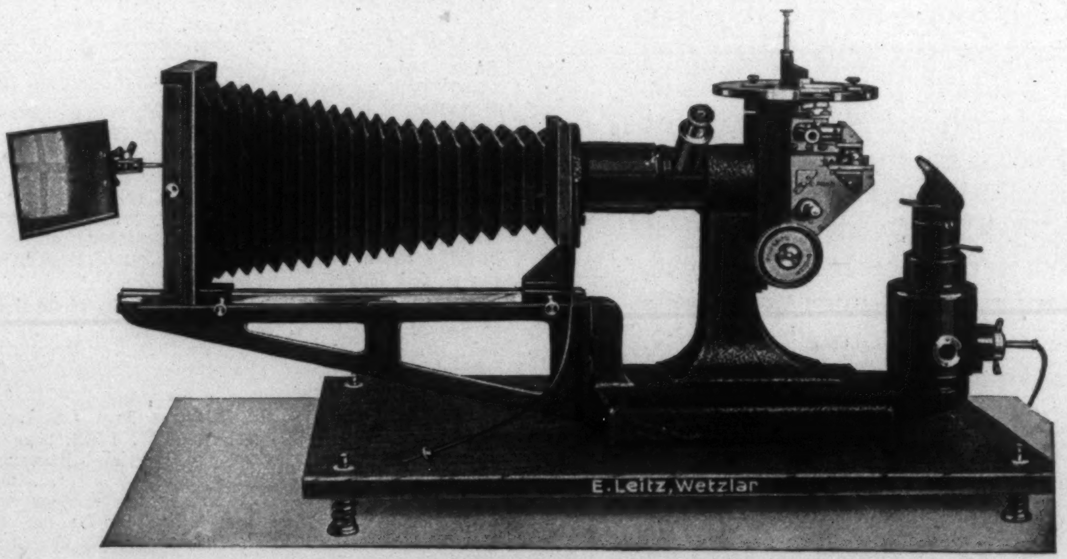

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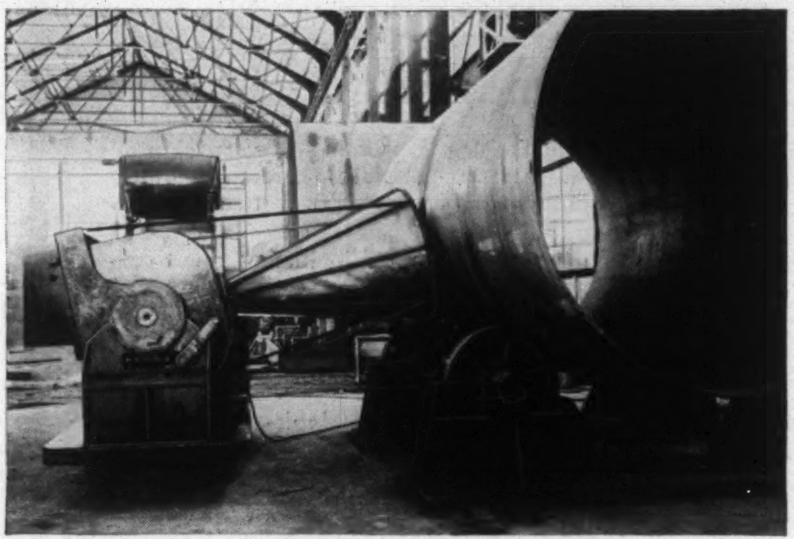

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Structure & X-Ray Analysis (5b)

Incidence of Lattice Distortion and Orientation in Cold-rolled Metals. W. A. WOOD. *London, Edinburgh & Dublin Philosophical Magazine & Journal of Science,* Vol. 14, Oct. 1932, pages 656-665. X-ray determination of rate of production of lattice-distortion and preferred orientation during cold-rolling. Examination was made of Cu and of an alloy consisting of 70% Ni, 25% Fe and 5% Cu, termed Mumetal. Results were confirmed on Ni, constantan, and transformer steels Fe-Al (Al 4%) and Fe-Si (Si 4%). Al, Pb and Bi, were found to exhibit no measurable distortion, and Pt very little. In general an alloy was found to be much more susceptible to lattice-distortion than any pure metal. Degree of distortion plotted against percentage reduction of thickness gives a definite type of curve, which is marked by an initial rapid rise of distortion to a constant value. This steady value is characteristic of metal. Preferred orientation appears after about 35 to 50% reduction, according to metal, and then grows rapidly. Lattice-distortion, when it occurs, reaches its maximum value before preferred orientation appears. The latter cannot play a primary part in the changes of properties produced by cold working. 6 references. RHP (5b)

Precision Measurements of Lattice Constants According to the Debye-Scherrer Method (Über Präzisionsmessungen von Gitterkonstanten nach der Methode von Debye-Scherrer) K. MÖLLER. *Die Naturwissenschaften,* Vol. 21, Jan. 27, 1933, pages 61-62. Experimental evidence gained on measurements with NaCl and Ag revealed the magnitude of deviations from the Bragg formula when determining the lattice constants with reference to symmetrical reflections. In case of unsymmetrical reflections, these deviations may exert a still greater influence upon the distortion of the reflection angle. According to the author's experiments the deviations from the Bragg formula are very considerable when studying finely crystalline matter and particularly a substance couple with different electron density and grain form. EF (5b)

Coarse-Structure Examinations with X- and Radium Rays, Their Application and Economy in Foundry Operation. (Grobstrukturuntersuchungen mit Roentgen und Radiumstrahlen, ihre Anwendbarkeit und Wirtschaftlichkeit im Giessereiwesen.) O. MIES. *Die Giesserei,* Vol. 19, Nov. 25, 1932, pages 485-486. Diagrams and tables were developed to determine average cost and output of radiation, according to size of equipment and inclusive of salaries, amortization, etc., total cost of an irradiation was found to lie between 0.5 and 5.00 R.M. Ha (5b)

Gamma Rays to Insure Internal Soundness. DARTREY LEWIS. *Metal Progress,* Vol. 24, July 1933, pages 29-31. Gamma rays from radium or radon are similar to X-rays and of about 1/10 the wave length of a 200,000 volt X-ray machine. They are absorbed and scattered less than X-rays through dense metals, hence have greater penetration. Photographs through 8" of steel have been made compared with the ordinary limit of 3½" for X-rays. Sensitivity to small defects is less than X-rays, but no special set-up is needed for irregular sections. 2 γ ray photos illustrate this point. Time of exposure is much longer than for X-rays, but for over 3" of thickness γ rays have definite advantages. Exposure time at 18" with 100 mg. of radium for Al and Cu alloys, and steel, of various thickness, is given in a table. 4 photos may be made at the same time of different specimens with one tube of radium or radon. Cost is \$1.13/ft.^{2} for 2400 photos per year (exclusive of overhead), compared with \$1.05/ft.^{2} for X-ray photo of Al castings, 25,000 per year. Ordinary X-ray film and screens are used at present. Much shorter exposure time has been reported by Pullin in Mar. 1933, *Engineering.* WLC (5b)

Reflection of Cathode Rays on Single Crystal Surfaces (Zur Reflexion der Kathodenstrahlen an der Einkristalloberfläche) SEISHI KIKUCHI & SHIGEO NAKAGAWA. *Scientific Papers Institute of Physical & Chemical Research,* Tokyo, Vol. 21, June 1933, pages 80-91. Experiments with 100 kv cathode rays on the cleavage plane (110) on a single ZnS crystal to check previous findings of Kirchner & Raether. (*Physikalische Zeitschrift,* Vol. 33, July 1, 1932, pages 510-513.) WH (5b)

Diffusion Velocity of Some Metals in Gold and Silver (Die Diffusions-geschwindigkeit einiger Metalle in Gold und Silber) W. JOST. *Zeitschrift für physikalische Chemie,* Abt. B, Vol. 21, Apr. 1933, pages 158-160. An X-ray method was used to determine the diffusion velocities of Pd, Pt and Cu in Au, and of Pd in Ag up to a maximum temperature of 1250° C. The experimental results are presented in a diagram. The correlation of diffusion speed to temperature could always be expressed by an exponential formula. EF (5b)

Testing of Welded Joints by X-Rays (Prüfung von Schweissnähten mittels Röntgenstrahlen) E. RÜTER. *Die Wärme,* Vol. 56, Jan. 28, 1933, pages 49-54. Paper before the Zentral Verband der Preussischen Dampfkessel Überwachungsvereine, Bad Nauheim, Sept. 1932, covers: non-destructive tests, X-ray equipment, fundamental remarks to the adoption of X-rays for material testing, inspection of materials of various compositions, determination of the depth of defects by stereograms, investigation of fusion welds, detection of rivet hole cracks and inspection of water gas welded joints. EF (5b)

A Method for Taking X-ray Photographs of Crystalline Powders at the Temperature of Liquid Air. J. A. SANTOS & J. WEST. *Journal Scientific Instruments,* Vol. 10, July 1933, pages 219-221. Description of a convenient and reliable method whereby X-ray photographs of finely powdered crystals can be taken at liquid air temperatures. RAW (5b)

Testing of Material with Gamma Rays (Werkstoffprüfung mit Gamma-Strahlen) *Die Metallbörse,* Vol. 22, Aug. 27, 1932, page 1103. In his lecture before the 37 General Meeting of the Deutsche Bunsengesellschaft für angewandte und physikalische Chemie, Riehl states that 30 mg. meso-thorium or radium are successfully used instead of X-rays to locate space cavities and other discontinuities. The exposure time rises from 2 hrs. for 10 mm. Fe thickness to 16 hrs. in case of 80 mm. wall thickness. Hair cracks in welded seams are only occasionally detected. EF (5b)

System Ag-Cu-Cd (Das System Silber-Kupfer-Kadmium) M. KEINERT. *Zeitschrift für physikalische Chemie,* Abt. A, Vol. 160, Nov. 1932, pages 289-304. The constitutional ternary diagram has been checked by microstructural investigations. In correspondence with the far going analogy between the Ag-Cd system on one hand and the Cu-Cd system on the other, the existence of ternary solid solutions of both the γ and ϵ phases was found while complicated transformations between the β and β' crystals are noticed, which could not be fully interpreted. Aging tests are performed on 12 high Ag alloys confirming former statements of Fraenkel & Nowack (*Zeitschrift für Metallkunde,* Vol. 20, 1928, page 243) that the maximum hardness value drops if Cu is below 6%. In most alloys (80-90% Ag), the hardness of the homogenized and quenched samples could be practically doubled by aging treatment. The experimenter found that Cd furthermore improves the aging possibilities in addition to Cu. Ag containing 20% Cu is discolored and subject to Cu-corrosion, but replacing 15% Cu by Cd induces the color of sterling silver and eliminates the menace of corrosion. EF (5b)

The Copper-Magnesium Alloys Examined Thermodynamically. F. H. JEFFERY. *Transactions Faraday Society,* Vol. 29, Apr. 1933, pages 550-553. Constitution of liquid solution of Cu-Mg is simplest possible consisting of monatomic molecules of Cu and Mg. Constitution of solid solution of Mg in Cu and of Cu in Mg is likewise simplest possible. Results are consistent with existence of compounds $MgCu_2$ and Mg_2Cu as shown by equilibrium diagram by W. R. D. Jones, *Journal of Institute of Metals,* Vol. 46, 1931, page 395. Other investigators examined this system by X-ray analysis and found a region of solid solution extending on both sides of the Cu_2Mg composition. This is at variance with the results of Jones. Results of work on thermodynamic analysis are all in agreement with the work of Jones. WAT (5b)

PHYSICAL, MECHANICAL & MAGNETIC TESTING (6)

Fatigue of Metals & Alloys (6f)

Investigation on Thin Walled Steel Pipes, Welded by the Arcatom-Welding Process (Untersuchungen an dünnwandigen, nach dem Arçatom-Schweissverfahren verschweisster Stahlrohre) HERMANN W. FRANKE. *Zeitschrift für Flugtechnik und Motorluftschiffahrt,* Vol. 24, Mar. 28, 1933, pages 170-172. See *Metals & Alloys,* Vol. 4, Aug. 1933, page MA 251. Kz (6f)

Atmospheric Action as a Factor in Fatigue of Metals. H. J. GOUGH & D. G. SOPWITH. *Engineering,* Vol. 134, Dec. 9, 1932, pages 694-696. See *Metals & Alloys,* Vol. 4, July 1933, page MA 214. LFM (6f)

Test Results and Service Value of Materials—I & II. H. F. MOORE. *Iron Age,* Vol. 130, Sept. 8, 1932, page 316, adv. sec. page 16; Nov. 10, 1932, pages 724-725, adv. sec. page 16. See *Metals & Alloys,* Vol. 3, June 1932, page MA 169. VSP (6f)

Effect of Zinc Coatings on the Endurance Properties of Steel. W. H. SWANGER & R. D. FRANCE. *Proceedings American Society for Testing Materials,* Vol. 32, Part 2, 1932, pages 430-452. Includes discussion. See *Metals & Alloys,* Vol. 4, June 1933, page MA 175. VVK (6f)

Fatigue Failures under Repeated Compression. H. R. THOMAS & J. G. LOWTHER. *Proceedings American Society for Testing Materials,* Vol. 32, Part 2, 1932, pages 421-429. See *Metals & Alloys,* Vol. 4, June 1933, page MA 175. VVK (6f)

Endurance Strength of Welded Joints of Different Shapes (Dauerfestigkeit von Schweissverbindungen bei verschiedener Formgebung) A. THUM & W. SCHICK. *Zeitschrift Verein deutscher Ingenieure,* Vol. 77, May 13, 1933, pages 493-496. The endurance strength of the original material, of V and X welds, butt and lap welds, and of different strap welds was determined by experiment; the results are tabulated in diagrammatic form and must be referred to. It was conclusively shown that the principles of modern construction must also be applied to welded joints, which means that the endurance strength of welds can be considerably increased by seeing to it that no accumulation of stress lines takes place near or in the weld. The designer must endeavor to shape a weld so that the stress distribution in the welded piece becomes as uniform as possible. Ha (6f)

What is this thing called Fatigue?

These abstracts are prepared in cooperation with the A. S. T. M. Research Committee on Fatigue of Metals.

Fatigue of Riveted and Welded Joints of Structural Steel (Die Dauerfestigkeit von genieteten und geschweissten Verbindungen aus Baustahl St. 52) E. H. SCHULZ & H. BUCHHOLTZ. *Stahl und Eisen.* Vol. 53, May 25, 1933, pages 545-553. A critical review. Laboratory fatigue tests can be used for evaluating various structural steels and joints but not directly as a basis for design calculations. The endurance limit in riveted joints depends on the holding power; in riveted joints of steel 52 (about 0.35% C) both the holding power and endurance is improved through the use of softer rivet steel, in particular with higher Ni or Mn rivet steel the joints have lower holding power and endurance. In welded joints the material of the base and electrodes is less important than the type of joint and the consequent stress distribution. A butt-welded joint is practically equal to a double-row riveted joint. Fatigue tests of large welded I beams of steel 52 showed that with proper design the endurance limit can be greatly increased so that such beams form a dependable structural element even under reversed stresses. There need be no concern that shrinkage stresses in welded joints will lower the endurance limit. The use of welded joints of steel 52 is entirely justified in structures which are not subjected to too high dynamic stresses. 17 references. SE (6f)

Fatigue of Shafts Having Keyways. R. E. PETERSON. *Mechanical World & Engineering Record,* Vol. 92, Nov. 11, 1932, pages 455-456. See *Metals & Alloys,* Vol. 4, Aug. 1933, page MA 251. Kz (6f)

Corrosion-Fatigue of Metals. H. J. GOUGH. *Engineer,* Vol. 154, Sept. 16, 1932, pages 284-286; *Engineering,* Vol. 134, Sept. 16, 1932, pages 323-324; *Metals & Alloys,* Vol. 4, Mar. 1933, pages 39-40. Extended abstract of 11th Autumn Lecture, Institute of Metals. See *Metals & Alloys,* Vol. 4, Aug. 1933, page MA 251. LFM + WLC(6f)

Surface Effect on Toughness and Endurance. ALBERT PORTEVIN. *Metal Progress,* Vol. 23, Apr. 1933, pages 51-58. Surface conditions very often have an important effect on resistance to shock and fatigue. Grinding furrows may reduce resilience, corrosion pits lower fatigue limit, or corrosion may dissolve grinding edges and thus remove "stress raisers." Decarburization, a chemical process, and cold work, a physical process, also affect surface conditions. These and other factors overlap and produce opposite effects in some cases, and have an important effect on the mechanical behavior of the metals. WLC (6f)

The Significance and Limitations of Fatigue Test Results. R. E. PETERSON & H. F. MOORE. *Preprint* No. 27, 1933, *American Society for Testing Materials,* 3 pages. Fatigue failure is perhaps the commonest type of failure in machine parts. It is comparatively rare in structures. Pressure vessels seem to be in an intermediate class. The endurance limit seems to be the best criterion for judging resistance of a metal to fatigue failure. At high temperatures, fatigue failure may be important below a certain temperature range, but above that range creep may become the dominant factor. In designing any machine or structural part, careful consideration should be given to the type or types of failure likely to occur and a criterion of strength should be selected only after such consideration. The term "fatigue of metals" should be used only in reference to actual failures of structural or machine parts by a spreading crack. VVK (6f)

Fatigue Fracture of Machine Parts (La rupture des pieces de machines par fatique) L. PERSOZ. *Aciers Spéciaux, Métaux et Alliages,* Vol. 7, Oct. 1932, pages 359-373; Dec. 1932, pages 428-436; Vol. 8, Feb. 1933, pages 36-49. 12 references. This study attempted to summarize most important results obtained on the phenomenon of fatigue, and principal causes of fatigue failure. Fatigue fracture develops gradually after the formation of a microscopic crack. Results obtained by Moore and Kommers (The Fatigue of Metals) are analyzed and discussed in detail. It was not possible to find any relation between endurance limit and other mechanical characteristics of a metal. Work of Ludwik (Congress of Materials, Zurich, Sept. 1931), of Kaufmann (*Metals & Alloys,* Sept. 1931, page 173) and of Junger were also discussed in detail. GTM (6f)

Cohesion Strength (Kohäsionsfestigkeit) W. KUNTZE. *Zeitschrift Verein deutscher Ingenieure,* Vol. 77, Jan. 14, 1933, pages 49-50. All methods of determining strength of a body use a definite shape of sample and a certain kind of stress, tension, shearing, bending, etc. The true strength of material depends, however, on cohesion between particles; and it is explained how an exact calculation of strength can be based only on the cohesion strength. A general discussion on present state of fatigue tests and the relations between static and dynamic values of strength leads to suggestions how to develop methods for measuring the cohesion strength of a material. See also *Metals & Alloys,* Vol. 4, Aug. 1933, page MA 249. Ha (6f)

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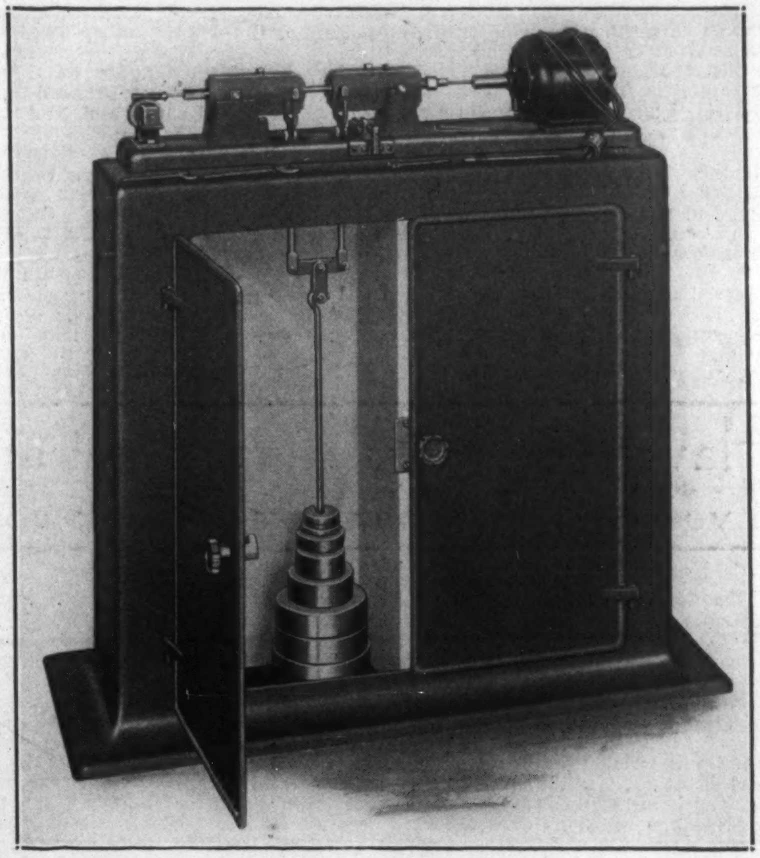

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ELECTRO-CHEMISTRY (7)

Electroplating (7a)

Requirements for Good Electroplating and Peculiarities of most Important Platings. (Die Voraussetzungen guter Elektroplattierungen und die Besonderheiten der wichtigsten Plattierungen.) Hugo Krause. *Oberflächentechnik,* Vol. 10, Jan. 17, 1933, pages 15-20. Mechanism of electroplating and proper operation of a plating bath is discussed and explained; principal factors are metal content in bath, energy of metal compounds contained in bath, and lastly regulation of current. Improper handling and impure chemicals as also often wrong layout of plating plant cause defects in finished product; most important rules: strictly clean work, correct composition of bath, clean anodes, stirring and filtering of bath. Current density and temperature must be so as to produce proper structure of deposit. All these points are discussed in detail with reference to specific conditions prevailing in electro plating of Ni, Fe, Zn, Cd, Sn, Pb, Cu, brass, Ag and Au. Ha (7a)

Modern Equipment for Electroplating. (L'appareillage moderne pour l'électroplastie.) A. Matagrin. *La Revue de Chimie Industrielle,* Vol. 41, Apr. 1932, pages 105-112; May 1932, pages 139-144. Some representative French electroplating plants are described and the operations preceding the electro deposition are considered at length besides the auxiliary equipment and the survey of the baths with emphasis on Cr and Cd plating. WH (7a)

Nickel Deposits. L. Wright. *Electrician,* Vol. 110, Mar. 10, 1933, pages 323-324. Discussion of some of properties which affect use of Ni deposits. Correct cleaning and pickling are necessary to obtain desired adhesion of Ni deposit. Adhesion is poor on steels containing Cr and W owing to presence of an invisible oxide film. Control of internal stress in Ni deposit is important. Applications of Ni deposits are based upon following properties: resistance to atmospheric corrosion; resistance to heat corrosion; resistance to chemical corrosion; resistance to wear and abrasion; and ease with which worn out parts can be built up. CBJ (7a)

Protection of Metallic Surfaces Against Corrosion (La Protezione delle Superficie Metalliche contro la Corrosione). Giac Bargellesi. *L'Industria Meccanica,* Vol. 14, Dec. 1932, pages 775-782. Mechanism of Ni plating, modern bath compositions and installations, operation and procedures for obtaining protection by Ni alone or with Cu and Cr, on various articles and metals are discussed; bath temperatures, current densities, pH-values and composition of bath are given in tables. Ha (7a)

Have you a plating problem?

If you have, these abstracts will help you.

The Calcium Fluoride Method for the Determination of Fluoride, with Special Reference to the Analysis of Nickel-Plating Solutions. S. G. Clarke & W. N. Bradshaw. *Analyst,* Vol. 57, Mar. 1932, pages 138-144. A precipitation method of determining amount of CaF_2 in Ni-plating baths containing additions of several kinds is described in detail. Ha (7a)

Peeling of Electrodeposited Nickel. E. A. Vueillenmier. *Quarterly Review of American Electroplaters Society,* Vol. 19, Jan. 1933, pages 10-14; *Metal Industry,* N. Y., Vol, 31, Apr. 1933, pages 130-131. When plating out Ni the metal has a tendency to contract. If the cathode is rigid it will not bend but the Ni will peel. This tendency is affected by the nature of the solution and is materially influenced by the presence of Fe in the electrolyte. Ni that is coarse and not shiny when deposited does not tend to peel. A long thin glass pointer attached to the bottom of a thin Pt cathode has been used to measure the tendency of the electrodeposited metal to contract. PRK (7a)

The Adhesion of Electrodeposited Nickel to Brass. A. W. Hothersall. *Sheet Metal Industries,* Vol. 6, July 1932, pages 164-173; Oct. 1932, pages 356-360. Paper read before the Electroplaters' & Depositors' Technical Society, May 1932. See *Metals & Alloys,* Vol. 3, Apr. 4, 1933, page MA 112. AWM (7a)

High Acid Chrome Plating Method. (Das Hochsäure Chromverfahren.) B. Rassow & L. Wolf. *Metallwaren Industrie und Galvano-Technik*, Vol. 30, May 15, 1932, pages 225-227. "Hochsäure" plating bath which is free from SO_4-ions (composition not stated) permits presence of 3.5% foreign acid content and even 4% at high current densities. Conductivity of new bath is superior to that of sulphate electrolytes. New bath is rather independent of CrO_3 concentrations. Variations between 150 g./l. and 400 g./l. influence efficiency but slightly. Writer claims that Fe content does not interfere, that corrosion protection of coatings is improved and that readily oxidizing metals can be Cr plated without any intermediate layer. A favorable operation is secured at a current density of 4 amps./dm.^{2}. EF (7a)

Progress in Electroplating. (Fortschritte in der Galvanotechnik.) Herbert Kurrein. *Oberflächentechnik,* Vol. 10, June 20, 1933, pages 141-144. New developments in 1932 with regard to depositing Cd, Zn, Cu, Ni, Cr, Sn, Pb and rare metals, and patents relating to it and methods of degreasing and pickling are reviewed. Cr and Cd are still actively investigated, Sn and Pb have not yet found a satisfactory solution for electroplating. Of rare metals, Pd plating is now frequently applied. Al is finished by anodic treatment of the surface. 103 references. Ha (7a)

Electroplating Zinc on Aluminum. Harold K. Work. *Metal Industry,* N. Y., Vol. 31, May 1933, pages 169-170. Taken from the Review of the American Electroplaters' Society. Zn was plated on unroughened Al by first applying a thin coating from a cyanide bath and then finishing the plating in an acid bath. Corrosion of alloy 17ST (Cu 4.0 Mn 0.5: Mg 0.5) in a 20% salt spray was temporarily prevented but "Alclad" 17ST was infinitely superior. Zn has little value in protecting 2S (commercially pure) Al. Zn-plating on Al is used to facilitate soldering in the rubber industry and in the radio industry. PRK (7a)

Electro-Plating Light Metals and Their Alloys. (Elektroplattierung der Leichtmetalle und ihrer Legierungen.) *Die Metallbörse,* Vol. 22, Aug. 13, 1932, pages 1038-1039. Zn and Cd furnished an excellent protective means against sea-air corrosion of light metals. The Royal Aircraft Establishment at Farnborough used a Zn sulphate-Na acetate solution to which 1 g./l. gum arabic was added. In cyanide-Zn solutions, the alkalies of the electrolyte react with the metal carrier, which effect can be counteracted by NH_3 additions. Sulphate baths yield coarse grained deposits. Most investigators apply Cd coatings without intermediary layers. Ni and Cr plating on Al are briefly reviewed. EF (7a)

Nickel-Plating Aluminum. *Chemical Trade Journal & Chemical Engineer,* Vol. 90, May 13, 1932, page 473. Abstract of a paper by A. V. Re before the Electrochemical Society. See *Metals & Alloys,* Vol. 4, Apr. 1933, page MA 113. JN (7a)

Layer-like Structures of Ni Deposits Prepared by Electrolysis. (Zonenartige Struktur elektrolytisch hergestellter Nickelschichten.) W. G. Burgers & W. Elenbaas. *Die Naturwissenschaften,* Vol. 21, June 16, 1933, page 465. X-ray diagrams of electro-deposited Ni layers of various thicknesses are given. The development of an oriented texture depends on many circumstances. Besides the generally known influence of the thickness of deposit (8-150μ), changes in the electrolyte, size of the vessel containing the electrolyte and agitation exert an effect. EF (7a)

Electrometallurgy (7b)

Separation of Lead and Zinc Electrothermally. (Sur la separation du plomb d' avec le zinc par voie électrothermique.) B. Bogitch. *Comptes Rendus,* Vol. 195, July 11, 1932, pages 127-129; *Journal du Four Electrique,* Vol. 41, Aug. 1932, page 287 (abstract). Experiments indicate: 1. Electrothermal method reduces to a minimum loss of metal in slag and gives intermediate products which are easily refined. 2. Amount of Pb carried with Zn into condensation chamber depends on amount of S left in the ore after roasting. 3. Amount of S which may be left in ore depends on content of Cu and Fe, with which metals S can form a matte. With complete absence of S deposits of Fe form on hearth of furnace and prevent its normal operation. 4. Sulphates cause excessive consumption of electrodes. JDG + OWE (7b)

Deposition of Beryllium on Copper and Other Metals by Electrolysis from a Molten Bath. (Die Abscheidung des Berylliums auf Kupfer und anderen Metallen mittels Schmelzflusselektrolyse.) H. Fischer & W. Schwan. *Metallwirtschaft,* Vol. 12, Apr. 7, 1933, pages 187-189. Be can be deposited on Cu and other metals by electrolysis from a molten bath of BeF_2 and NaF in graphite crucibles. Particular care must be taken to eliminate H_2O from bath, which can be done by addition of NH_4F. Current efficiency increases from 20% at 550° C. to 88% at 800°, then drops with increasing temperature. Deposit is smooth and has good adherence. Between 550° and 750° surface is steel gray, above 750° it becomes yellow. At 800° efficiency drops from 90% at 1000 amps./m.^{2} to 10% at 7750 amps./m.^{2}. Yield of Be increases steadily for about 2 hours, then drops off suddenly, and practically no more is deposited after 4 hours. Maximum thickness of Be layer obtainable is about .1 mm. Be diffuses relatively easily in pure Cu, less in Be-Cu alloy, and hardly at all in pure Be. As speed of diffusion of Be on surface of metal decreases, adherence becomes poorer and Be layer becomes rougher. Attempts to increase thickness of deposit by depositing Cu with Be and by periodically heat treating deposit between stages of electrolysis were unsuccessful. Be can also be deposited on Ni, Fe, Al, Sn bronze and brass, but in smaller quantities. 6 references. CEM (7b)

Modern Electrodeposition. C. C. Downie. *Electrical Review,* Vol. 111, Nov. 4, 1932, page 666. Superposition of a.c. or d.c. eliminates passivity and other retardation phenomena, the important factors being ratio of a.c. to d.c. strength and the frequency employed. Superposed a.c. permits use of greater c.d. of d.c. Applied first in refining of gold, latest use is in the breaking up of complex alloys. Best results are obtained by introducing a.c. and d.c. simultaneously. Alloys, such as Ni-Cr-Zn series containing impurities of Fe, Sn and Sb, are cast into anode plates, which are placed in earthenware or fibre diaphragms. Electrolyte is usually either a H_2SO_4 or HCl solution. It is sometimes necessary to deposit Cu first, remove the cathodes, and replace the starting sheets. Composition of bath is then altered and the Ni is deposited on Fe starting sheets. Anode sludge is removed, dried, melted with suitable fluxes, and cast into anode plates. Electrolysis is now conducted in an alkaline electrolyte, and the Sn separated from Pb. MS (7b)

Electrolytic Preparation of Metallic Lithium. N. A. Isgarischew & S. A. Pletnev. *Tzvetnuie Metallui,* No. 4, Apr. 1932, pages 537-542. (In Russian.) Molten mixture of equal weights of LiCl and KCl was electrolyzed in an iron cell lined with talcum stone, using a graphite anode and iron cathode. Experiments were made on small scale and repeated on semi-commercial scale. Capacity of cells was 1 kg. of metallic Li per day. A current of 225 amp. and 17 volts was used. Power consumption was 75 KWH. per kg. of Li, and the recovery about 85%. The Li obtained contained 0.23% K, 0.19% Mg, and 0.5% Na. The Na which came from the KCl used in the experiments can be eliminated by using Na-free KCl. Mg can be eliminated by means of preliminary treatment of talcum walls with molten salt. BND (7b)

Anodic Solution of Copper-Tin Alloys. Yu. V. Baimakov & R. B. Popov. *Tzvetnuie Metallui,* No. 4, Apr. 1932, pages 513-536. (In Russian.) Existing methods of separation of Sn from anode slimes resulting from electrolysis of bronze have many disadvantages, such as their complexity, high cost, and contamination of product by other metals. In order to recover both Sn and Cu of high purity authors investigated conditions of electrolysis of bronze, whereby, instead of allowing the Sn contained in alloy to go into anode slime, it is dissolved and maintained in the dissolved state in the electrolyte for considerable time. The Sn then may be easily recovered in pure form directly by electrolysis after the Cu has been extracted, or by hydrolysis followed by reduction with C. The authors succeeded in developing a method whereby 99% of Sn was retained in solution in the electrolyte, and the Cu obtained was 99.93% pure. As the result of a series of very carefully controlled experiments authors established the following: 1. The higher the Sn content of the anodes the greater part of it is dissolved and kept in solution. 2. With the increase in the acidity of electrolyte the loss of Sn in slime is decreased. 3. The temperature of the electrolyte should be maintained at 15-20° C. 4. Agitation should be accomplished either mechanically or by the flow from one tank to another, but under no circumstances by air. On the contrary, it is recommended to keep the surface of the electrolyte covered with oil or kerosene in order to prevent the oxidation of bivalent Sn to tetravalent, and its hydrolysis. 5. The current density at the anode should be high (120-150 amp./m.^{2}) and at the cathode low (70-80 amp./m.^{2}). In other words, the area of the anodes should be about ½ that of the cathode. The higher current density at the anode prevents the oxidation of stannous oxide to stannic, and maintains higher acidity. With lower current density the oxidation takes place with decrease in acidity and subsequent hydration of stannic oxide, which then goes into the slime. 6. The current concentration in bath should be high. 7. The formation of Cu threads extending from anodes in the direction of the cathodes can be prevented by the introduction of 0.6 cc. HCl/l. of electrolyte. 8. In the electrolysis, as high concentration as 10 g. Cu/l. and 50 g. Sn/l. can be allowed without affecting the quality of the cathode Cu. 9. Addition of small amounts of Cu in the form of Cu sulphate to the electrolyte is recommended. 10. Pb and Zn are slightly harmful and should be eliminated from the anodes if possible. 11. Preliminary annealing of the anodes improves anodic dissolution and decreases the loss of Sn in slime. BND (7b)

Electricity as Energy Source in Metallurgical Processes. (Elektrizität als chemische Energiequelle für hüttenmännische Prozesse.) *Technische Blätter der deutschen Bergwerkszeitung,* Vol. 23, Aug. 20, 1933, page 450. Abstract of paper by Brenthel before Electro-Heat Meeting of Verband Sächsischer Elektrizitätswerke, May 16, 1933. Particularly refers to electrolytic processes used by the Halsbrücker Hüttenwerke for refining Cu, Pb, Ag, Ni, Al, Mg, production of metal compounds etc. GN (7b)

Production of Purest Metals by Thermal Dissociation. (Die Herstellung reinster Metalle durch thermische Dissoziation.) *Die Metallbörse,* Vol. 22, Dec. 17, 1932, page 1614. Experiments of van Arkel on the deposition of W, Zr, V, Ti, B from W chloride, Zr iodide, V iodide, B bromide and Ti chloride. EF (7b)

Preparation of Oxygen-free Be. (Zur Herstellung oxydfreien Berylliums.) *Die Metallbörse,* Vol. 23, Jan. 7, 1933, pages 18-19; Jan. 14, 1933, pages 50-51. Brittleness of "pure" Be (99.7-99.8% Be, 0.01% Fe, 0.05% C, 0.05% N, 0.2% O) is ascribed to the presence of O. Electrolysis in CO_2 is most promising. According to Sloman, no reaction between Be and CO_2 takes place below the m.p., however the graphite electrodes interfere. Replacing the electrode material did not yield any tangible result. Experiments in a bath of 1 part Na-fluoride + 2 parts Be-fluoride are reviewed. The deposits were free from O_2 but the thickness never exceeded 0.25 mm. The balance of the article discusses further experiments with the aim of securing Be free from oxygen conducted along the following lines (1) decomposition of Be salts under exclusion of air, (2) electrodeposition in nonaqueous solutions, (3) sublimation of Be and (4) deoxidation of oxygen bearing metal. EF (7b)

METALLIC COATINGS OTHER THAN ELECTROPLATING (8)

Surface Treatment of Light Metals. (Oberflächenbehandlung von Leichtmetallen.) R. LEONHARDT. *Oberflächentechnik,* Vol. 10, May 2, 1933, pages 106-107. General discussion of surface treatment for decorating or protecting by polishing, grinding, metallic coating or painting. Preparation of objects for treatment and the treatment itself are described briefly. The best protection for light metals from corrosion is obtained by a layer of pure Al, as this is most resistant against almost any attack. This coating is to be applied usually in the semi-finished state as the finished product cannot be provided with this layer. Alclad, Allautal, Duralplat, etc., are such materials which are made of an ingot on which the pure Al is rolled and then the whole ingot is rolled out for the desired product. Ha (8)

Application of Gas to the Tinplate and Sheet Industries. A. D. HOWELLS. *Gas Journal,* Vol. 201, Feb. 8, 1933, pages 313-316. Abridged from a paper before Wales and Monmouthshire Junior Gas Association meeting at Neath, Jan. 28, 1933. Includes discussion. Several diagrams illustrating various types of furnaces are included. Local method by which tinplates are made is discussed, giving a detailed description of various parts of furnaces such as recuperator and burners. Essential features of tinpots are outlined. Data on efficiency is included. MAB (8)

"Zinkan," a New Material for Cable and Insulated Wire Fabrication. ("Zinkan" ein neuer Werkstoff für die Kabel- und Isolierdraht-Fabrikation.) J. F. KESPER. *Technische Blätter der deutschen Bergwerkszeitung,* Vol. 23, June 18, 1933, page 343. Zinkan is Al plated Zn sheet, produced by rolling Al on Zn sheets under pressure while hot. Best results are obtained when Zn sheet contains small amounts of Al. Due to easy workability and good insulating properties the new material is best fit for the purposes of the cable industry. Zinkan is adaptable to all shaping processes and can be soldered and welded. GN (8)

Some Reactions Occurring in "Hot-Dipping" Processes. EDW. J. DANIELS. *Metal Industry,* London, Vol. 41, Nov. 4, 1932, pages 447-450. See *Metals & Alloys,* Vol. 4, Mar. 1933, page MA 68. Ha (8)

Investigation of Occurrences during Galvanizing. (Untersuchungen über die Vorgänge beim Verzinken von Eisen.) HERIBERT GRUBITSCH. *Monatshefte für Chemie,* Vol. 60, June 1932, pages 165-180. Samples of sheet steel of various C contents were dipped in Zn in N atmosphere free from O and then examined. Solubility curves of pearlitic steel with C up to .60 in molten Zn are given, which have similar forms. The maximum solubility lies between 480° and 520°C. and varies in magnitude, but has no direct relation to C content. The thickness of the alloy layers was calculated from the solubility curves and checked by microscopic examination. The structure of the Zn layer on pearlitic steels up to .60 C depends definitely on the temperature of dipping and is very characteristic for several temperatures. There are relations between the solubility of Fe in Zn and the structure of the Zn layer at various temperatures. The solubility of steel is greater in commercial than in c.p. Zn. 21 references. CEM (8)

Metallization by Means of the Spray Pistol. (Metallisierung mittels Spritzpistole.) F. GERBER. *Die Metallbörse,* Vol. 23, Apr. 22, 1933, pages 510-511. The evolution of the Schoop metal spray method is traced with particular emphasis on the perfection of the pistol. The "Elektro Metall-pistole" permits the atomization of high melting metals such as W, Cr, Mo, Pt. The writer states that "it is possible to heat the metal to nearly 4000°C." In the pistol, which weighs about 1.5 kg., 2 wires of 1 mm. diameter are moved towards one another and fed by 40 volts. The occurring arc heats the metal to extreme temperatures. A.c. and d.c. can be used. The efficiency is doubled as compared with the previous oxy-hydrogen pistol while expenses are lowered. The advantages of this coating method are pointed out and compared with other metallic coating processes. Pb coatings on concrete are recommended. If 6-7 atm. pressure are applied wood can be provided with a metallic coating. The metal particles are travelling at a speed of 800 m./sec. The repair of fractures designated as "cold welding" has been successfully experimented with. EF (8)

Depositing Oxide Film on Aluminum. A. EYLES. *Metal Industry,* N. Y., Vol. 31, Jan. 1933, page 17. Abstract "Technika" No. 44, 1932. A thin heat resisting, heat conducting, flexible, strong, and electrical insulating film is deposited on Al by treating it with oxidizing chemicals at high temperatures assisted by an electrolytic process. An oxide film has also been deposited on Cu conductors preliminarily covered with Al. PRK (8)

Testing Zinc Thickness of Galvanized Wire. Z. DYAKONOVA. *Tzvetnuie Metallui,* No. 4, Apr. 1932, pages 550-552. (In Russian) Suggested method consists in dissolving off of a definite thickness of Zn and detecting presence of bare iron. It was found that by the use of a solution of As_2O_3 in H_2SO_4, a uniform dissolution of Zn oxide and Zn can be accomplished. By dipping a wire previously cleaned in benzene or ether, in such a solution and holding 15 sec. from the moment of the appearance of first bubbles, a layer of Zn 0.0001 cm. thick is dissolved off. The wire is then washed in water and quickly dipped into a concentrated solution of $(NH_4)_2S$. If any bare iron is present, black spots due to the formation of FeS will appear on the portions of the wire unprotected by Zn. To ascertain the presence of FeS the wire is placed for a short time in strong acetic acid (3 cc.), removed, and 2-3 drops of $K_3Fe(CN)_6$ are added to the solution. The change in the color of the solution indicates the presence of iron. BND (8)

Metal Spraying as a Protection against Corrosion. W. E. BALLARD. *Metallurgia,* Vol. 8, July 1933, pages 67-69. Discusses the many uses of sprayed metal. Thick Zn coats can be economically sprayed on steel. Pure Al can be sprayed on Al alloy castings to increase their resistance to corrosion. Sprayed coatings are even satisfactory for dairy equipment. JLG (8)

Galvanizing Large Transmission Towers. *Steel,* Vol. 91, July 11, 1932, pages 23-26. Description of modern galvanizing plant of extra-large capacity, Canadian Bridge Co., Walkerville, Ont. The automatic temperature control system for the two 90-ton galvanizing units is described at length. JN (8)

Sherardizing and Oxidizing of Cast Iron Parts. (Das Sherardisieren und Inoxydieren von Gusstellen.) *Zeitschrift für die gesamte Giessereipraxis,* Vol. 54, June 4, 1933, pages 221-222. Discussion of both of the processes used for increasing the corrosion properties of castings. The latter method is simpler and more advantageous. Two methods of oxidation are described, the Chemag method and the Citoxit method. GN (8)

Amalgamating Copper Plates. *Engineering & Mining Journal,* Vol. 134, Aug. 1933, page 321. Cu plates are easily and cheaply amalgamated by application of a soft mush composed of NH_4Cl 80%, moistened with 20% of water and sufficient Hg dispersed through it. A large shallow enameled pan and a watertight wooden box will serve as receptacle for the mush. Grease on the plate should be removed, as it prevents amalgamation of the Au. WHB (8)

Metal Depositing by the Spray Process. *English Mechanics,* Vol. 14, May 5, 1933, pages 41-42. Considers the coating of metals, wood, fabric, etc., with any metal or alloy capable of being drawn into wire (1-1.5 mm.) and of being melted in any oxy-coal gas, oxy-hydrogen or oxy-acetylene flame. The spraying with Al is emphasized in view of the unsuccessful attempts at electro-deposition, as well as the absence of distortion in case of hot galvanizing, Sn dipping (tanks) and spraying of fragile material. The pistol weighs 3½ lbs., operates at a pressure of 30 lbs./in.^{2}, and runs at 12,000-40,000 r.p.m. The metal particles travel at 760 miles/hr. The mechanical details of the pistol are fully explained and illustrated. WH (8)

Effect of Impurities of Steel on Galvanizing Embrittlement. (Einfluss der Verunreinigungen des Stahles auf die Verzinkungsbrüchigkeit.) *Die Metallbörse,* Vol. 34, Feb. 25, 1933, page 242. Based on 9 references, the effect of As, Sn, Cr, Cu, C, P, N and O is reviewed. EF (8)

INDUSTRIAL USES & APPLICATIONS (9)

Shaft Rings of Structural Steel St. 52. (Schachtringe aus Baustahl St. 52.) J. KUSENBERG. *Stahlbau,* Vol. 6, Feb. 17, 1933, page 31-32. In recent years several mine disasters were due to inadequacy of cast Fe shaft rings (failure on account of disturbances in the uniform radial earth pressure). Author investigated applicability of structural steel St. 52 and found that use of this steel instead of former cast Fe tubes considerably increases the safety of a mine shaft in areas of floating sand. GN (9)

Metallic Linings for Digestors. WALLACE C. JOHNSON. *Paper Trade Journal,* Vol. 96, Mar. 9, 1933, pages 33-35. Cr-Ni pipe and digestor fittings led to use of this material for digestor linings. Failures resulted from difference in expansion between Cr-Ni linings and steel shell. Problem was solved by making a composite plate using an intermediate bond sheet to permit Cr-Ni to expand independently of steel base to which it is welded. Arc welding is used for fabrication of lining or of new digestors. CBJ (9)

Welding Aids Food Purity. O. C. JONES. *Journal American Welding Society,* Vol. 12, Feb. 1933, page 16. In order to more effectively combat corrosion, a large chocolate manufacturing concern has replaced its tanks and vats with tanks of welded stainless steel. TEJ (9)

Steel Developments of the Past Year. L. SANDERSON. *Steam Engineer,* Vol. 2, Feb. 1933, pages 226, 223. Interesting developments of 1932 include (1) casting of steel crankshafts, (2) manufacture of light steel castings, (3) use of alloy cast Fe for boilers, (4) nitriding, (5) 2-ply stainless steel, (6) Se stainless steel, (7) stainless steel castings, (8) replacement of C tool steel by alloy steels and (9) development of Cr alloy steel for the wearing parts of crushing machinery. AHE (9)

This is the age of metals and alloys.

Whether it is a tiny piece of some relatively rare metal for a radio tube or a huge alloy forging for an oil still. These abstracts will tell you what is going on.

Large Uses of Steel in Small Ways. 221st Article. Wrecking Tools. *Steel,* Vol. 91, July 11, 1932, page 34. The production of wrecking bars and wrecking chisels, used in the demolition of buildings, requires 4000 to 5000 tons of steel annually. JN (9)

Large Uses of Steel in Small Ways. 222nd Article. Pipe Vises. *Steel,* Vol. 91, July 25, 1932, page 32. The manufacture of hinged, heavy-duty pipe vises uses up 900 tons of steel and malleable iron castings a year. JN (9)

Large Uses of Steel in Small Ways. 224th Article. Handcuffs. *Steel,* Vol. 91, Aug. 22, 1932, page 33. The manufacture of handcuffs, twisters, nippers, and leg and arm shackles for law enforcement purposes requires 10 to 15 tons of steel annually. JN (9)

Large Uses of Steel in Small Ways. 225th Article. Automatic Door Controls. *Steel,* Vol. 91, Sept. 5, 1932, page 30. Description of several types of automatic door controls using photo-electric cells, for industrial, commercial and private buildings. JN (9)

Large Uses of Steel in Small Ways. 226th Article. Kodak Film Spools. *Steel,* Vol. 91, Sept. 19, 1932, page 29. In the manufacture of all-steel spools and metal flanges for wooden-core spools, Eastman Kodak Co., Rochester, N. Y., consumes 1300 tons of flat strip steel annually. This requires 16,000,000 linear ft. of strip, 0.10 to 0.30 in. thick and 1 to 5 in. wide. JN (9)

Large Uses of Steel in Small Ways. 227th Article. Railroad Car Pre-coolers. *Steel,* Vol. 91, Oct. 3, 1932, page 32. Pre-cooling units for cooling railway passenger cars, waiting rooms, rest rooms, etc., each contain about 1500 lbs. of steel and iron. These units draw out the warm air through a canvas duct, cool it with an ice-water spray and return the cool, clean air through a second canvas duct. There are about 500 units in operation. JN (9)

Large Uses of Steel in Small Ways. 228th Article. Photo-mechanical Whirlers. *Steel,* Vol. 91, Oct. 17, 1932, page 38. The manufacture of metal printing plates for photo-engraving and lithography requires the use of steel whirling machines for driving off the surplus sensitizing liquid and producing an even distribution of the film. These machines vary all the way from huge motor-drive units to small, simple, hand-operated types. JN (9)

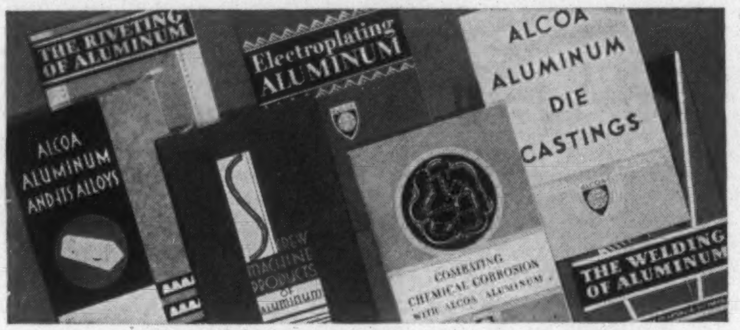
Large Uses of Steel in Small Ways. 229th Article. Motor Car Rims. *Steel,* Vol. 91, Oct. 31, 1932, pages 27, 29. In normal times, 165,000 tons of steel are consumed annually in the production of rims for passenger car, truck, motorcycle and airplane wheels. Practically all rims today are made for balloon tires, and 90% of wheels produced are of the wire type. Statistics of rim production since 1925 are given for each field of service. JN (9)

Large Uses of Steel in Small Ways. 230th Article. Anvils. *Steel,* Vol. 91, Nov. 14, 1932, page 34. The manufacture of anvils requires 500 tons of steel annually. They range from a few lbs. to 800 lbs. in weight. The better anvils are cast in one piece of electric furnace alloy steel. Some anvils consist of a forged top, welded at the waist to a cast steel or cast Fe base. Smaller anvils may be cast entirely of Fe. JN (9)

Large Uses of Steel in Small Ways. 231st Article. Lapel Buttons and Clips. *Steel,* Vol. 91, Nov. 28, 1932, page 34. Lapel buttons used in political campaigns, drives, society meetings, etc., are made of 33-gage tin plate. The designs are lithographed directly on the metal; the buttons are then stamped out, formed and fitted with brass pins. They may be $\frac{13}{16}$″ or ⅝″ in diam. Rectangular identification clips are made of 28-gage tin plate and may measure 2⅝″ x 1⅜″. JN (9)

Large Uses of Steel in Small Ways. 232nd Article. Measuring Tape. *Steel,* Vol. 91, Dec. 12, 1932, page 35. Several thousand lbs. of steel are consumed annually in manufacture of steel measuring tapes. These are made of high C cold rolled flat strip steel in lengths of 25 to 100 ft., ⅛ to ⅜″ in width and 0.004 to 0.018″ in thickness. Larger tapes may be 300 to 1000 ft. long. Marking, etching and finishing are conventional processes. JN (9)

Large Uses of Steel in Small Ways. 233rd Article. Pipe Cleaners. *Steel,* Vol. 91, Dec. 26, 1932, page 28. The manufacture of pipe cleaners for smokers' use requires 50 tons of light, thin steel wire annually. This represents about 77,000,000 cleaners. The cleaners are about 6″ long and are composed of 2 strands of crimped wire woven together with one strand of cotton or wool yarn. JN (9)



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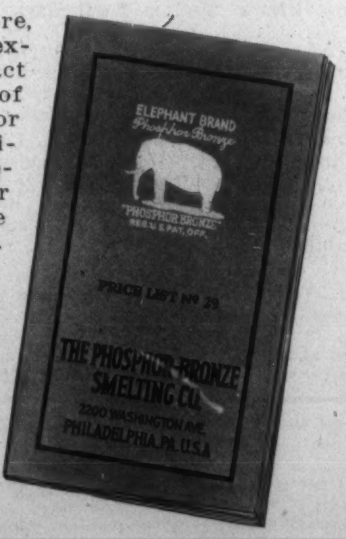

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Lead Bronze in Automobile and Aircraft Motor Construction. (Bleibronze im Automobil- und Flugmotorenbau.) ERICH SEMMLER. *Deutsche Motorzeitschrift,* Vol. 10, June 1933, pages 120-126. Tendencies to replace ball bearings by plain bearings and to reemploy genuine Cu-Sn bronzes are pointed out. Bearings on Pb-Sn base failed in main and connecting rod bearings due to excessive hardness and were replaced by white metal bearings (80% Sn, Brinell = 30). The latter do not withstand high temperatures since the intermediary layer of Sn between the white metal bearing and the Fe shell begins to melt at 250°C. Recent investigations showed that high Pb low Sn alloys yield satisfactory service. An alloy of 60 Cu, 20 Pb, 8 Sn and Sb additions withstands a specific load of 240 kg./cm.^{2} Discontinuing lubrication, no damage was noticed after running 3 min. at 70 kg./cm.^{2} load. This is ascribed to the formation of a protective Pb film. The composition has been changed by utilizing low additions of Ni and Fe to Cu-Pb bronzes in order to check Pb segregations. The properties of the Admos bronze (no analysis given) are emphasized: resistance to 300 kg./cm.^{2} load, intimate contact between bearing metal and carrier, self-lubricating Pb film, higher m.p. (casting temperature = 1200°-1400°C.), greater hardness, longer life times. Curves of properties, microstructures, defective bearings, etc. EF (9)

Turbine Nozzles and Diaphragms. S. D. SCORER. *Mechanical World & Engineering Record,* Vol. 93, May 19, 1933, pages 474-475. In case of saturated steam turbines the nozzle holders are often made of cast iron or gunmetal, the cast-in plates being of Cu. For use with superheated steam the nozzle holders may be of cast iron, cast steel, cupro-nickel alloy, with cast-in plates of stainless or Ni steel, or Monel metal. The application of the various materials for nozzles and diaphragms in case of different types of turbines are gathered in a table. Kz (9)

Materials for Steam Turbines. S. D. SCORER. *Electrical Review,* Vol. 112, May 12, 1933, page 664. Outline of characteristics of metals used for steam-turbine parts. Coarse-grained cast-Fe should be used only when mechanical and thermal stresses are low. For moderate temperatures, fairly close-grained pearlitic cast-Fe should be used. Cast-Fe for a high-pressure casing should be of pearlitic close-grained structure. Cast-steel is used for high-pressure sections. Casting is annealed at 1200°-1600° F. before rough machining, and after first operation, it is annealed at 1000° F. Mild steel is commonly used for steam pipes, operating gear, rotors, etc. Forgings are also heat treated. Brass, Ni, stainless steel, and other materials are used for blades. Alloy cast-irons and steels, particularly those containing Ni and Cr, are coming into use for steam-turbine work. MS (9)

Constructive Improvement of Steel Castings for Trucks. (Die konstruktive Verbesserung der Stahlgussteile an Lastkraftwagen.) A. WALLICHS & W. MENDELSON. *Automobiltechnische Zeitschrift,* Vol. 35, Nov. 25, 1932, pages 536-544. Shape of a steel casting as determined by its employment in automobile trucks is discussed and required strength determined. Piece must be designed so that shape makes possible production of sound castings, especially so as steel castings incline to formation of pipes and cracks on account of its great shrinking. General directions are developed for production of sound castings with special reference to requirement in trucks and several examples of housings for the differential, brake drums, etc. are illustrated giving old and new methods. Ha (9)

Relative Wear of Metals Due to Abrasion. C. R. WEISS. *Iron Age,* Vol. 129, May 26, 1932, pages 1166-1167, 1180; *Mechanical World & Engineering Record,* Vol. 92, July 8, 1932, pages 28-29. Abstract of paper read at joint meeting of Materials Handling Institute and American Foundrymen's Association at Detroit. To ascertain material best suited to insure maximum wear value at minimum cost for power chain purposes, Link-Belt Co. developed apparatus described. Includes tables giving abrasion test values of heat-treated steels and also of other steels and metals. Low C steel used as comparator material. Kz + VSP (9)

New Material for Radio Tubes. HAROLD C. TODD. *Radio Engineering,* Vol. 12, Sept. 1932, pages 18-20. "Svea" plate and wire consist of a special type of exceptionally pure Swedish iron made by a secret process. Characteristics of this metal are tabulated. WHB (9)

Acid-Resisting Pumps. C. H. S. TUPHOLME. *Chemical Markets,* Vol. 33, July 1933, pages 40-42. A discussion of centrifugal pump design and materials for pump construction. Special reference is given to the corrosion resistance and mechanical properties of the chromium-nickel steels of the VA group. RAW (9)

Steel Used in Racing Automobiles. J. W. URQUHART. *Blast Furnace & Steel Plant,* Vol. 21, Mar. 1933, pages 159-160, 170. Discusses composition, treatment, and forging of laminated steel springs. Composition of finest material is 0.50-0.60% C; 0.50% Si; 0.40-0.80% Mn; 0.05% P and S; 0.15% V; and 0.50-1.00% Cr. Oil quenching temperature is 850° C., tempering, 300° C. At Brinell hardness of 241-311, tensile strength is 55-65 tons/in.^{2}. Stamping or forging temperature is about 1250° C. Thorough forging insures a high degree of resistance to fatigue. Tests conducted by the Springs Research Committee showed that machining and polishing of plates after heat treatment was necessary to obtain high resistance to bending fatigue. MS (9)

Contact Rails for Cranes and Loading Plants. P. VAHLE. *Engineering Progress,* Vol. 13, Sept. 1932, pages 204-205. Contact rails made of trolley wires lack stability, with consequent uneven and premature wear as well as unreliable contact of the contact shoes. These drawbacks are eliminated by Cu-headed steel contact rails. They consist of a steel bar of T-section with a special head to which a copper bar is fastened. The Cu bar is securely fastened to the steel rail. Brinell hardness of the Cu is about 90 to 100. RHP (9)

Cause and Prevention of Cylinder Wear in I.C. Road Engines. R. WAKE. *Mechanical World & Engineering Record,* Vol. 92, July 15, 1932, pages 60-62. Efficiency of internal combustion engines depends mainly on the condition of the cylinder bores, valve seats, and pistons. The causes of wear are summarized. In spite of hardness and density of cylinder-block castings, good machinability is desired. Slow cooling of castings and Si convert the combined C into graphitic C, bringing about a softening of Fe. Excess of Si creates a tendency to porosity and water leakage. Analysis of medium grade cylinder cast iron: 2.20-3.10% C; 1.20-2.07% Si; 0.80-0.90% P; 0.87-1.25% Mn. Improvements are obtained by the addition of Ni and Cr. Their effect is shown. A wear resisting Fe alloy for heavy duty high-speed engine cylinder blocks is: C = 3.45%; Si = 1.24%; Mn = 0.61%; S = 0.14%; P = 0.34%; Ni = 1.67%; Cr = 0.34%. To withstand high temperatures and pressures, pistons are usually made from "Y" alloy containing: 3.50-4.50% Cu; 1.80-2.30% Ni; 1.20-1.70% Mn; 93.50-91.50% Al. The B.H.B. piston with its self-adjusting properties when running under heavy-duty conditions, is made of the R.R. 50 alloy the average composition of which is given as follows: Ni = 1.3%; Cu = 1.3%; Mn = 0.1%; Fe = 1.0%; Ti = 0.18%; Sb = 2.2%; Al = 93.92%. Kz (9)

Non-ferrous Metals in Railway Electrification. FR. A. WESTBROOK. *Metal Industry,* London, Vol. 41, Nov. 25, 1932, pages 515-516. Attention is called to great amounts of non-ferrous metals, beside Cu and Al, that are used in electrification of main line and interurban and street car lines. Ni, Zn, Pb, Sn forming greater part of electrification programs of several countries with the amount of metals involved are briefly discussed. Ha (9)

All-Welded School Building. A. H. WETH. *Welding Engineer,* Vol. 17, Nov. 1932, pages 32-33. Erection of a building 140 x 89 ft. and a height of 31 ft. is described; it took 15 working days. An itemized cost account (except electric current) is given; the total cost per ton of steel was $8.03. Ha (9)

A Talk about Steel. T. W. WILLIS. *Journal Institution of Production Engineers,* Vol. 12, July 1933, pages 295-308. The characteristics and methods of treating tool steels are described—mainly as they concern the machine shop supervisor. JCC (9)

HEAT TREATMENT (10)

Salt Baths Have Not Kept Pace with Other Heat-Treating Methods. SAM TOUR. *Iron Age,* Vol. 130, Sept. 22, 1932, page 462. Extension of use of salt baths has not continued during the past 5 years at the rate comparable with preceding 5 years. States the cause of the conditions. Also briefly describes the "Hultgren" type of salt bath and the controlled atmosphere type of Globar heated electric furnaces. VSP (10)

Heat Treatment of Rope Wire. R. SAXTON. *Mechanical World & Engineering Record,* Vol. 93, June 30, 1933, page 621. Objects of heat treatment in rope wire manufacture are to remove the stresses set up by previous hot or cold work, and to produce a uniform grain size giving high tensile strength and ductility in the finished wire. "Patenting," and the pan or pot method for heat treatment are discussed. For high-strength wire the crystal size should be medium. Kz (10)

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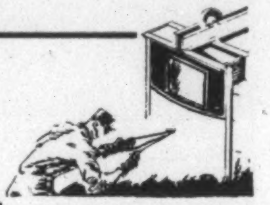

Effect of Heat Treatment on the Forming Properties of Aluminum Alloys. J. A. NOCK, JR. *Metal Stampings,* Vol. 5, Apr. 1932, pages 261-266. Working characteristics and mechanical properties of Al alloys such as duralumin, 25S, 51S, etc., are improved by heat treatment. Annealing, which softens the alloy, is accomplished by heating to 650°F. or 800°F. and cooling slowly. Solution heat treatment, which increases tensile strength and hardness, is carried out by heating to 925°-970°F. and quenching. Precipitation heat treatment, or aging, is usually carried out at 250°-320°F. This results in an increase in tensile strength, yield-point, and hardness, with a decrease in ductility. Annealing is done in an air atmosphere. For light to medium sections, solution heat treatment is usually carried out in a bath of fused $NaNO_3$. Heavy sections are more advantageously treated in air furnaces. Aging may be done in fan-equipped ovens heated by steam coils or electricity. MS (10)

The Heat Treatment of Gage Steel. F. A. W. LIVERMORE. *Mechanical World & Engineering Record,* Vol. 92, Oct. 21, 1932, pages 381-383. Ideal heat treatment conditions would be realized if it were possible to transmit simultaneously to each particle of the steel a given amount of heat in a given time. Mass phenomena that limit the approach to this ideal are discussed. In the heat treatment of gage steel the change of austenite to martensite resulting in an expansion, or of martensite to pearlite with a contraction, are of importance. An experimental furnace is described. Tools were quenched from 750°C. with whale oil at about 25°C. Specimens heated to 260°C. and cooled in whale oil gave the best results. The approach to recovery of original dimensions after tempering is shown in the following table:

	Before hardening	After hardening	After tempering
Top diameter	1.2000	1.2010	1.2002
Effective diameter	1.2169	1.2172	1.2168
Core diameter	1.4642	1.4649	1.4643

Kz (10)

Preserving Surface During Heat Treatment. J. W. URQUHART. *Mechanical World & Engineering Record,* Vol. 92, Nov. 11, 1932, pages 457-458. Bright steel immersed in a salt bath is instantly covered with an oxygen-excluding envelope. The surface continues to be protected until the pieces are immersed in the quenching tank. Kz (10)

Heat Treatments of Nickel-Chromium Stainless Steels. (Traitements thermiques des aciers inoxydables au nickel chrome.) A. MICHEL. *Revue du Nickel,* Vol. 3, July 1932, pages 105-108. Two objects for heat treating austenitic stainless steels: (a) the solution of all phases into austenite; (b) the release of stresses. The velocity of cooling after the solution treatment must be such, and any further reheating made in such a way, that no carbides may precipitate. Carbides originate usually at grain boundaries and lead to intercrystalline corrosion. A C content lower than 0.04% is the best preventive against intercrystalline corrosion. Cr, W, Mo, V, Si, Ti, Al, are added to steel of the 18-8 type to prevent intercrystalline corrosion. It is not yet known if their effect is that of the formation of the δ phase or of carbides. The presence of the δ phase is not a sufficient and necessary condition for resistance to intercrystalline corrosion. AH (10)

Effect of Furnace Atmosphere on the Hardening Properties of Steel. (Ugnsatmosfärens inverkan pa härdbarheten hos stal.) BENGT KJERRMAN & IVAR BOHM. *Jernkontorets Annaler,* Vol. 117, May 1933, pages 243-261. Laboratory investigations showed that with excess air stronger case hardening occurred than with a deficiency. The former condition did not give complete carburization. Hence the preheating to hardening temperature should take place in a reducing atmosphere but the hardening should be concluded with a short oxidizing period. Practical tests on the hardening of inner rings for roller bearings resulted in the following recommendations for case hardening: Cold rings are charged into the furnace at 830°C. The charge cools the furnace to 680°C. in 10 min. An air/gas ratio of 3.5 is then maintained until 800°C. is attained, when the gas flow is cut to two-thirds. About 5° before the hardening temperature is attained the air/gas ratio is increased to 7.0. This ratio can be controlled solely by the appearance of the material. It is important to avoid too high an air/gas ratio. HCD (10)

Free-Wheeling Rolls Must Withstand Severe Shocks. K. L. HERRMANN. *Machinery,* Vol. 38, Aug. 1932, pages 881-885. Chromium steel S.A.E. 52100 is used for the rolls. Rods are first spheroidized. Considers heat treating which brings them to 57-59 on Rockwell C scale. Considers tempering and testing. RHP (10)

New Heat Treatment for Carbon Steel Locomotive Castings. A. W. GREGG. *Iron Age,* Vol. 131, Feb. 2, 1933, pages 192-193, adv. sec. page 18. Describes treatment which involves quenching in water followed by drawing, a practice hitherto not permitted by railroads for such castings. Gives details of practice followed at the plant of Bonney-Floyd Company, equipment used and high physical properties obtained. VSP (10)

Heat Treatment of Cast Iron. H. BORNSTEIN. *Metal Progress,* Vol. 24, Aug. 1933, pages 31-35. Annealing of cast iron is conducted to relieve stresses, soften or machining, or for malleableizing. The effects of various heat treatments are discussed and hardnesses obtained are shown graphically. Nitriding is briefly discussed. WLC (10)

Receipts for Treating Steel. *Mechanical World & Engineering Record,* Vol. 92, Sept. 16, 1932, page 266. To prevent high-speed steel tools from warping secure (1) uniformity in heating and (2) avoid rapid initial heating by using a liquid heating medium, (3) avoid irregular quenching by employing a heated bath instead of oil or air. At 595°-650°C. the tools cool evenly with a rate of heat extraction corresponding to the conductivity. Below this temperature quench in oil. Kz (10)

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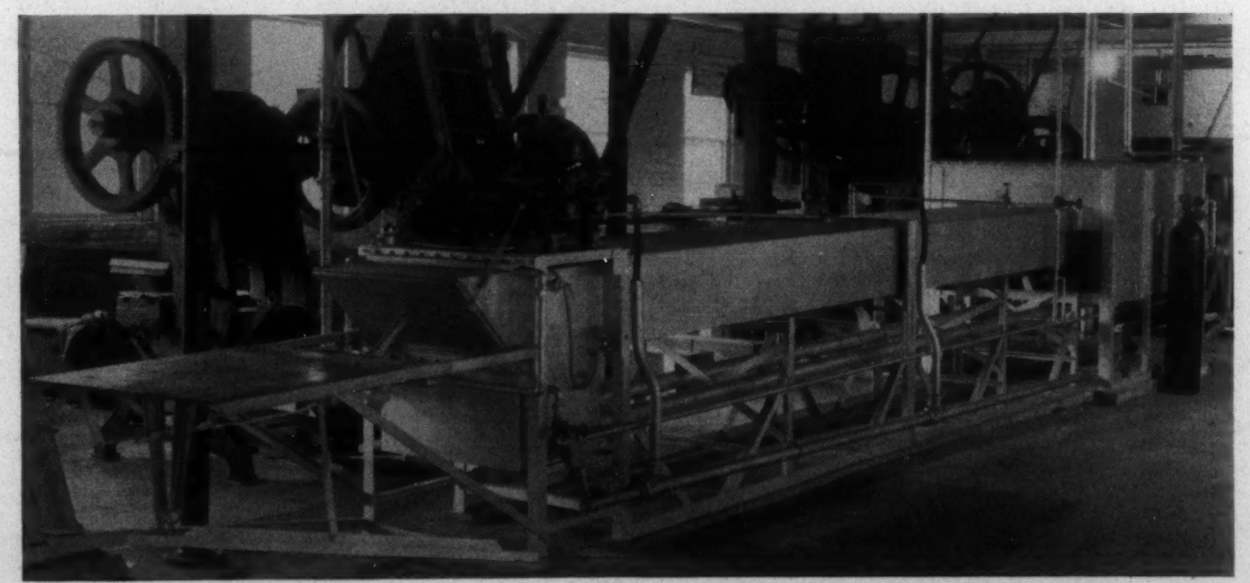

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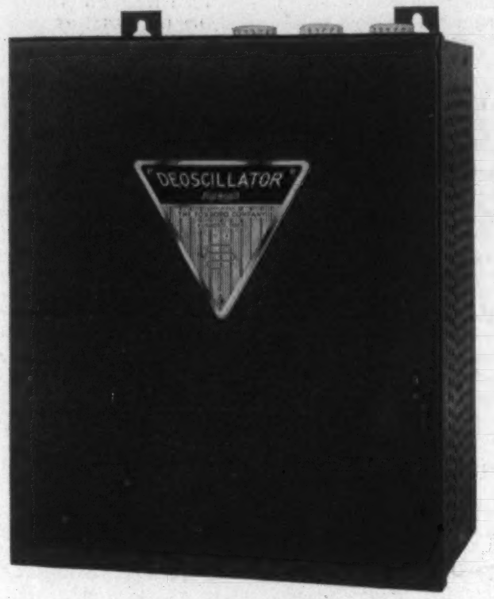

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Hardening (10a)

Production Problem Solved by Continuous Liquid Heat Treatment. W. GORDON PARK. *Iron Age,* Vol. 129, Feb. 1932, pages 444-445, Adv. sec. page 26. See "Continuous Liquid Heat Treating Process," *Metals & Alloys,* Vol. 3, Aug. 1932, page MA 248. VSP (10a)

Apparatus for Hardening Delicate Work. HUBERT R. SCHMIDT. *Machinery,* Vol. 38, July 1932, pages 842-843. Illustrates and describes a device for holding small materials while heat treating. Deals primarily with a device for holding latch needles. RHP (10a)

Hardening of Pocket and Table Knives. (Härten von Tisch- und Taschenmessern.) REISER & RAPATZ. *Anzeiger für das Berg-, Hütten und Maschinenwesen,* Vol. 55, Jan. 20, 1933, page 7. The blade of a table knife is hardened at dark-red heat by dipping it in water in an oblique direction with the back of the blade touching the water first. It then is drawn at violet or blue. 6 or more blades are held together with tongs. In drawing, the knives bend easily since the thin edge is at temperature sooner than the back. This might be avoided by drawing in salt baths. RV (10a)

Three More Letters About Magnetic Hardening. H. J. WIESTER, YOSIHARU MATUYAMA & ED. G. HERBERT. *Metal Progress,* Vol. 23, Mar. 1933, pages 46-49. Wiester and Kussmann tested a 0.72% C steel, heated to hardening temperature in a vacuum, quenched in water, and polished. After seasoning for several days it was subjected to a magnetic field of 7000 oersteds and tested for hardness, both pendulum and Rockwell. No increase was noted. No strengthening effect on an anneal at 100°C. was noted in other tests. Hardness increased 1.5 units on magnetically treated and control specimens. Matuyama repeated Herbert's experiments with negative results. A graph of local variations in hardness from a given point on a test plate is given. Age hardening curves of a 0.6% C steel and duralumin quenched from 790° and 500°C. respectively show no considerable effect of repeated magnetic treatment. Herbert points out that the Herbert pendulum measures hardness under load and takes account of elastic and plastic deformation. The Vickers machine, which Matuyama used, measures plastic deformation only and is incapable of measuring elastic changes which are principally involved in magnetic treatment. The air gap used by Herbert was 3 mm. Matuyama used a wider one, to which he attributes Matuyama's lack of success. Herbert alleges that other workers have reproduced his results in spite of the inability of these correspondents to do so. WLC (10a)

Interrupted Hardening of Carbon Steel. DARTREY LEWIS. *Metal Progress,* Vol. 23, Apr. 1933, page 49. An investigation of interrupted hardening of an 0.8% C steel wire 0.192" diameter was recalled by Diergarten's article in March *Metal Progress.* Quenched from 1500°F. into a salt bath at 450°, this steel was fully austenitic and non-magnetic for 5 min. at this temperature and could be easily bent or formed in that interval. Hardness was C-25. At room temperature, hardness was C-59. The material transformed to martensite regardless of cooling speed. Shop value of the method was suggested to use in avoiding quenching strains by slow cooling from the salt bath. Also pressing and forming could be done while soft. Diergarten was unable to get good interrupted hardening of a similar material in ½ in. disks, quenched in oil at 480° and cooled in water. WLC (10a)

Hardening of Special Cast Irons by Development of Martensite. L. GUILLET, J. GALIBOURG & M. BALLAY. *Iron Age,* Vol. 130, Sept. 29, 1932, page 497. Abstract translation of paper in *Revue de Métallurgie,* Nov. 1931. Results of quenching on physical properties and structures of special cast Fe compounded in crucible are discussed. VSP (10a)

Hardening an 8-ft. Gear-wheel. *Mechanical World & Engineering Record,* Vol. 93, Feb. 17, 1933, page 149. Illustrated discussion of hardening of a double-helical gear 8 ft. in diameter, having 180 teeth and 12" width of face by the "Shorter" process. Kz (10a)

Progress in Metal Hardening. *Mechanical World & Engineering Record,* Vol. 92, Oct. 7, 1932, pages 338-339. Deals with development of Shorter hardening process, object of which is to harden wearing surface of hardenable iron and steel locally and to produce, by means of mechanically controlled heating and quenching media a hardened zone of metal. Hardening is effected by an oxy-acetylene flame, followed by a cooling jet to quench the heat imparted to the surface. Kz (10a)

Treatment of High Speed Cobalt Steels. (Die Behandlung von Kobaltschnellstählen.) *Die Metallbörse,* Vol. 22, July 2, 1932, page 835. Co renders the steel tough and heat resistant. Cutting speeds can be increased 15-30%. The hardening treatment is more complicated and shaping involves some difficulties. Finishing treatment by grinding is indispensable. It is brazed to a carrier so that only the edge consists of Co steel. Hardening temperature = 1250°-1300° C., drawing temperature = 570°-600° C. EF (10a)

Annealing (10b)

Bright Annealing Furnace Installations Type Brown-Boveri-Gruenewald. (Blankglühofenanlagen Bauart Brown-Boveri-Gruenewald.) H. NATHUSIUS. *Zeitschrift Verein deutscher Ingenieure,* Vol. 76, Dec. 10, 1932, pages 1221-1224. Often occurring oxidation of charge during cooling is prevented in Gruenewald-process by employment of an air-tight lid on annealing box by means of rubber gaskets which, however, are arranged in such manner that they are out of range of heating zone and cooled by water. Constructive details of furnace temperature distribution in interior and control of atmosphere is described. By placing a dish with small ferro-manganese pieces and some linseed oil this furnace is suitable for bright annealing. Ha (10b)

Blister Formation during Heat Treatment of Age-Hardening Aluminum Alloys. (Die Blasenbildung bei der Wärmebehandlung aushärtbarer Aluminiumlegierungen.) P. BRENNER, F. SAUERWALD & W. GATZEK. *Zeitschrift für Metallkunde,* Vol. 25, Apr. 1933, pages 77-80. Formation of blisters on annealing commercial Al alloys—13 alloys generally of the duralumin type—is dependent on both the annealing conditions and the composition of the alloy. Blister formation is aggravated by salt-bath annealing, relieved by annealing in vacuum or in argon; it is aggravated by polishing and by working. The blisters are aligned in the direction of rolling, and seem localized at points in which the poly-eutectic occurs. The formation of blisters is explained by the gas content, especially the H content, of the metal. Illustrated by numerous pictures of blisters. RFM (10b)

Research in Bright Annealing Brass and Other Metals. *Metal Industry,* N. Y., Vol. 31, Jan. 1933, page 16. Report by the American Gas Association of the progress made in 1932 in bright annealing metals. PRK (10b)

Large Castings Improved by Air Cooling. T. N. ARMSTRONG. *Metal Progress,* Vol. 23, Apr. 1933, pages 33-35. Medium (0.30) C steel and alloy castings used for naval purposes are discussed. The effects of double annealing on the physical properties are contrasted with those for quenched and tempered steel. Normalizing (air quenching) is used for large castings where liquid quenching is impractical. The treatment given is normalizing from 1700° to 1800° F., and tempering to required ductility, 1100° to 1250°. The castings are prevented from cooling below 600°, except after final tempering which is done in the furnace. A 26 ton rudder frame casting was given this treatment without warping or cracking. A spheroidizing treatment for castings over 0.30% C improves ductility. The treatment is the same as given above with a prolonged anneal at 1250° to 1300° after normalizing. WLC (10b)

Case Hardening & Nitrogen Hardening (10c)

Case Hardening Steel; Modern Electrical Methods. JOHN DUMMELOW. *Electrical Review,* Vol. 113, July 28, 1933, pages 115-116. Outline of cyaniding and nitriding processes, with special reference to the latter, and brief description of the equipment used. MS (10c)

Gaseous Cementation of Steel. E. C. COOK. *Heat Treating & Forging,* Vol. 18, Sept. 1932, pages 531-534; Oct. 1932, pages 588-590, 608; Nov. 1932, pages 642-644. Review of the work of Bramley and his associates published in Iron and Steel Institute, Carnegie Scholarship Memoirs, v. 15-18, 1926-1929, with comments based on practical experience in commercial carburization. Describes first the laboratory apparatus used and discusses the nature of the tests. Bramley observed that when CO is used as the carburizing gas, presence of moisture, even in traces, has a deleterious influence. He did not study effect of moisture in gases other than CO. R. G. Guthrie, however, recommends a low moisture content when hydrocarbon gases are employed as the carburizing agent. Although Bramley concludes that gas flow should be reversed during cementation period, successful commercial installations show that reversal of flow is unnecessary if flow of gas is uniform and at the proper rate and temperature for the gas in question. It was to be expected that as Bramley found a considerable flow of CO was necessary to obtain carburizing at the maximum rate possible with it, Bramley's results with regard to CO saturated with $CH_3C_6H_5$ are in complete accord with American practice. In this case, increase of flow, beyond a certain point, proves a deterrent to successful carburizing rather than a favorable factor. MS (10c)

Quenching (10d)

Transformations During the Hardening of Steel. (Über die Umwandlungen bei der Stahlhärtung.) F. WEVER. *Zeitschrift für Metallkunde,* Vol. 24, Nov. 1932, pages 270-275. Includes discussion. Paper before the Deutsche Gesellschaft für Metallkunde, June 26, 1932. A summary of Wever's work. (See *Metals & Alloys,* Vol. 2, page 9; *Mitteilungen a.d. Kaiser-Wilhelm-Institut für Eisenforschung,* Düsseldorf, Vol. 14, 1932, pages 71, 85.) RFM (10d)

Quench Cracks in Forgings. BERNARD THOMAS. *Heat Treating & Forging,* Vol. 18, Oct. 1932, pages 577-579. Discusses conditions leading to the occurrence of quenching cracks and means for their prevention. Among factors causing cracks are patches of scale on surfaces; burns; laps; seams; piping; segregation; shape of piece, such as presence of sharp angles, shoulders, and corners; small mass; and unsuitable composition. MS (10d)

Effect of "Facing" on the Cooling Velocity of a Specimen During Quenching. S. SATO. *Kinzoku no Kenkyu,* Feb. 1933, pages 63 to 70 (In Japanese); *Science Reports Tohoku University,* Vol. 21, 1932, pages 564-574. A method of quenching, which has been the practice of Japanese cutlery makers for a long time, is to face the surface of the specimen to be hardened with a mixture of "tonoko" i.e. the very fine powder from a razor whetstone and water, and to dry the specimen prior to the quenching operation. This process is said to be absolutely indispensable to obtain a perfect hardening. Since "tonoko" is powdered clay slate and a poor conductor of heat, a coating of this material even though a very thin layer, may at first be thought to have the effect of preventing the quick cooling of the specimen. Cooling curves were taken automatically during quenching by means of special apparatus, and it was confirmed that a more drastic and uniform quenching may be effected in the case of specimens with facing than in the case of those without facing. An unfaced specimen heated to a high temperature is, when quenched, at once covered with a vapor envelope given off by the cooling medium, and as the vapor is a poor conductor of heat, the cooling of the specimen is thereby greatly retarded, until the envelope begins to break and a direct contact of the specimen with the cooling medium takes place; then an abrupt increase in the cooling velocity which is indicated by a break in the temperature-time curve results. Faced specimens are never enveloped by vapor film and, therefore, their cooling is very rapid and uniform throughout the specimen. Thus the old technique of quenching steel specimens with facing is very useful; it gives them an intense and uniform hardening. KT (10d)

Water-on-Oil for "Graded Hardening." R. KIMBARA. *Metal Progress,* Vol. 23, June, 1933, page 46. C and low alloy steels hardened 1st in the water layer of a water-on-oil bath, for a definite time, then dropped in the oil layer below, show greater hardness than obtainable in water alone. The oil is specially refined so as to settle immediately even on vigorous stirring. A table shows the increase in hardness of 3 steels, including a 5.5% W steel usually very brittle on hardening, but very tough after hardening in the combination bath. Drawing is sometimes unnecessary after such hardening, fine grain and toughness being obtained without further treatment. The results agree with Diergarten's theory of "graded hardening." Slow cooling transforms the retained austenite directly into a tough structure of ferrite and cementite. WLC (10d)

Temperature Control of Quenching Baths-Discussion. E. E. HALLS. *American Machinist,* Vol. 76, Apr. 7, 1932, page 461. Discussion of R. H. Ure's notes on the above in *American Machinist,* Vol. 75, page 968. Oil quenching baths present a real fire hazard. Flash point on most oils when new is from 200° C. up. Burning points from 20 to 30° C. higher. Gives a table of flash and ignition points of quenching oils. Briefly discusses hydrogen occlusion, and plating of springs. Controlled electroplating processes do not mean prohibitive costs. RHP (10d)

Aging (10f)

Age Hardening in Low Carbon Strip Steel. EARL B. WHITTEMORE. *Transactions American Society for Steel Treating,* Vol. 21, June 1933, pages 571-576. This article previously abstracted from *Metal Progress,* Vol. 22, Oct. 1932, pages 50-52. See *Metals & Alloys,* Vol. 4, Oct. 1933, page MA 321. WLC (10f)

A Low Internal Stress Heat Treatment. CHARLES W. BRIGGS. *Transactions American Society for Steel Treating,* Vol. 21, May 1933, pages 424-434. Includes discussion. See *Metals & Alloys,* Vol. 4, Oct. 1933, page MA 321. WLC (10f)

Rapid Aging of Hot Steel Test Piece. KOTARO HONDA. *Metal Progress,* Vol. 23, May 1933, pages 41, 43. Offers as an explanation of the serrated stress-strain diagram of steel tests bars pulled between 100°-300° C. that since aging is greatly accelerated by increase in temperature, age hardening follows rapidly upon the first yielding of the specimen, thus producing a higher yield point as more load is applied. The same type of serrated stress-strain curve would be obtained with other materials that age harden after cold work and the range of temperature in which such serrated curves were obtained would depend upon the relative velocities of aging and yielding at those temperatures. WLC (10f)

Influence of Previous Treatment upon Mechanical Properties and Electrical Conductivity of Magnesium-Silicide Alloys. (Der Einfluss der Vorbehandlung auf die mechanischen Eigenschaften und die elektrische Leitfähigkeit von Magnesium-silizidhaltigem Aluminium.) G. GRUBE & F. VAUPEL. *Zeitschrift für Metallkunde,* Vol. 25, Apr. 1933, pages 84-88. The alloy Aldrey, containing 0.61% Si, 0.26% Fe, 0.45% Mg, the rest Al, was studied. Data were obtained, shown in tables and by curves, for tensile strength, elongation, and electrical conductivity as functions of time of aging after quenching; aging was performed at room temperature, and at 155° C. after simple quenching and also after quenching and cold-drawing. It is concluded that Aldrey aged at room temperature is not a suitable material for electrical conductors, but that a treatment consisting in quenching, cold-drawing, and aging supplies a suitable material for this purpose. RFM (10f)

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JOINING OF METALS & ALLOYS (11)

Welding & Cutting (11c)

Automatic Welding of Automobile Stampings. A. F. DAVIS. *Metal Stampings*, Vol. 5, Apr. 1932, pages 253-256. Points out that automatic arc welding promotes the use of steel stampings in the automotive industry. Illustrates typical welded stampings and modern welding equipment therefor. MS (11c)

Electric Arc Welding. N. GRANT DALTON. *Transactions South African Institute of Electrical Engineers*, Vol. 23, Nov. 1932, pages 310-326. Resistance-, butt-, spot-, seam- and arc welding are outlined. Under latter class: the Zerener between C and C process, the Benardos between metal and C process, and the Slawianoff between metal and metal arc process are included, also automatic welding processes and their applications. A discussion follows. WHB (11c)

Discussion of Papers Presented at New York Section Meeting Held on Dec. 13, 1932. W. P. CURLEY. *Journal American Welding Society*, Vol. 12, Jan. 1933, pages 15-16. Discussion of papers read at Dec. 13, 1932 Joint Meeting of New York Section, American Welding Society and the Petroleum and Power Division, American Institute of Mechanical Engineers. An interesting example of corrosion and erosion of welded piping is described. TEJ (11c)

Investigation on Thin Walled Tubes Welded according to Arcatom Method. (Untersuchungen an dünnwändigen, nach dem Arcatom- Schweissverfahren verschweissten Rohren.) W. FRANKE. *Zeitschrift für Flugtechnik und Motorluftschiffahrt*, Vol. 24, Mar. 28, 1933, pages 170-172. Welding of airplane parts is discussed with special reference to successful application of Arcatom method. GN (11c)

Pipe Welding. J. J. CUMMINGS. *Welding Engineer*, Vol. 18, Apr. 1933, page 26. Some observations on proper procedure of large pipe jobs, testing and supervision are discussed. Ha (11c)

Position Finder Facilitates Welding of Heavy Piling. A. F. DAVIS. *Journal American Welding Society*, Vol. 12, Jan. 1933, page 30. Description of a novel method used to facilitate handling and welding heavy steel piling. TEJ (11c)

Have You a Joining Problem?

From January to Dec. 1933 this section digested 645 articles on welding, cutting, soldering, brazing and riveting.

All-Welded Steel Condensers. CLETUS F. FOX. *Power*, Vol. 76, Nov. 1932, pages 230-231. Prize winning paper in Lincoln Arc-Welding Prize Competition. Replacement of castings by steel plates, arc-welded, made a gross saving of 41% in the cost of construction of the surface condenser for a 35,000-kw. turbine. Cost data are given. AHE (11c)

Sales Advantages of Welded Products. J. J. FIECHTER. *Journal American Welding Society*, Vol. 12, Jan. 1933, pages 16-17. Paper presented at Annual Meeting, International Acetylene Association, Philadelphia, Nov. 1932. Simplified design, speed in preparation for production, low cost of preparing for production, good appearance, durability and low production costs are good selling points of a welded article. TEJ (11c)

Arc Welding is Penetrating New Construction Fields. B. FERGUSON. *Journal American Welding Society*, Vol. 12, Mar. 1933, pages 12-13. A brief description of the construction of an all welded steel water storage tank of 6,000,000 gal. capacity. Over 700 tons of steel were welded together. TEJ (11c)

Some Notes on Welding Aluminum and Duralumin. A. EYLES. *Mechanical World & Engineering Record*, Vol. 91, Mar. 4, 1932, page 228. For joining Al fusion welding is the more satisfactory method while the problem of welding duralumin has not been finally mastered. In arc-welding of Al and its alloys the electrodes are usually of the flux-coated type and success depends a great deal on the use of a suitable flux. Discussing methods and technique of welding preheating of Al castings to 500°-750° F. is desirable. For best results in duralumin heat treatment (900° F.) after welding and quenching are essential. If joining duralumin in structural work, riveting is preferable. Kz (11c)

Welded Steel Underframes for Railway Wagons. S. E. EVANS. *Welder*, Vol. 4, Apr. 1933, pages 25-27. Describes test of a welded steel underframe, showing advantages of this type of construction over that usually employed. TEJ (11c)

A New Fabrication Job. DE WITT ENDICOTT. *Journal American Welding Society*, Vol. 12, Jan. 1933, page 31. How a welded steel assembly was substituted for a cast iron cylinder head. TEJ (11c)

Making Four Hundred Welded Steel Pulleys a Day. M. L. ECKMAN. *Machinery*, Vol. 38, Apr. 1932, pages 576-579. Describes and illustrates processes in manufacture of pulleys by Barry Mfg. Co., Muscatine, Iowa. Outstanding features: hexagonal hub, tubular construction, assembly by Federal resistance welding equipment. Pulleys range in diameter from 3" to 72". RHP (11c)

Welded Reservoir. K. S. GUREVICH. *Azerbaidzhanskoe Neftyanoe Khozyaistvo*, Jan. 1933, pages 70-74. (In Russian.) A number of methods adopted in the United States for welding large size oil containers are discussed. AAB (11c)

Welded Tank for Highly-concentrated Caustic Liquid. (Ein geschweisster Behälter für hochkonzentrierte Lauge.) E. GREGER. *Der Autogen Schweisser*, Vol. 5, Oct. 1932, pages 218-221. Investigations on caustic embrittlement of boilers have shown, that these defects, depending on the caustic concentration of boiler water, originate at places of highest stress where boiler material has been cold worked. Article gives particulars on a method employed for oxy-acetylene welding of a tank for highly-concentrated lye. The weld proved to withstand caustic embrittlement successfully. Kz (11c)

Rating Metallic Arc Electrodes. J. B. GREEN. *Welding Engineer*, Vol. 18, Feb. 1933, pages 16-17. Selection of welding rods is usually made according to property of weld to be made. Physical properties of weld metals and present testing methods are discussed. Unification of tests and specifications is recommended. Ha (11c)

Modern Weld Testing. J. B. GREEN. *Welding Engineer*, Vol. 18, Jan. 1933, pages 25-27. Preparation of samples for testing welds by mechanical and radiographic tests according to rules of A. S. M. E. Boiler Construction Code is described and its importance for procedure control emphasized. Several test results are given. Ha (11c)

Repairing Castings by Fusion Welding. (La Réparation des Pièces de Fonderie par Soudure Autogène.) HENRI GERBEAUX. *Bulletin de l'Association Technique de Fonderie*, Vol. 7, Jan. 1933, pages 2-15. Principles of welding steel, cast Fe, Cu and Al alloys. Welds should be considered as small castings. Oxidation, shrinkage, and contraction must be taken into account. Cooling rate affects structure of the weld and the adjacent metal. In welding cast Fe the deposited metal should be a cast Fe. A chloride mixture is used as a flux in Al welding. This flux must be thoroughly removed after welding to prevent corrosion. WHS (11c)

WORKING OF METALS & ALLOYS (12)

Melting & Refining (12a)

Function of Aluminum in Deoxidation of Steel on Basic Slag. (La funzione dell 'Alluminio nella disossidazione dell-acciaio su scoria basica.) G. Guzzoni. *Alluminio,* Vol. 1, Nov.-Dec. 1932, pages 355-360. Action of Al, as well as other deoxidizers, on basic steel is reviewed, and equilibria of FeO, Fe, in presence of Al, C, Mn, Si, calculated, by means of law of mass action. Al is the most efficient deoxidizer, as 0.1% Al will reduce FeO content to 0.00145%; in comparison, same amounts of C, Mn, Si, reduce FeO to 0.125, 1.19, and 0.082%. However, for some purposes Al has an injurious effect, i.e., on heat treatment, cold-rolling, and wire-drawing. AWC (12a)

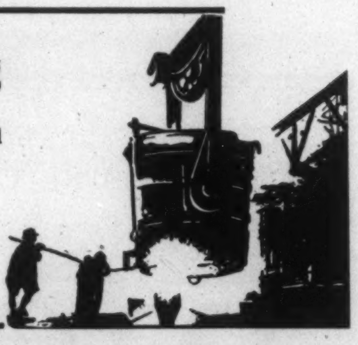
Some Experiences in Making Rimming Steel. H. D. Hibbard. *Fuels & Furnaces,* Vol. 10, May 1932, pages 323-332, 355. Relates some experiences in cases where rimming steel was used for low C steels. As a general rule it may be said that in making rimming steel O must be freely served to the metal to ensure the proper quantity of gas being evolved in the mold. The method of making rimming steel by acid and basic excess of pig methods is described, and the influence of rate of teeming, thickness of mold, application of Al discussed with illustrations of defects in the structure due to wrong procedures. Ha (12a)

Oxides in Metal Castings. (Oxyde im Metallguss.) F. Höhne. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 54, Jan. 8, 1933, pages 13-14; Jan. 22, 1933, pages 35-36; Feb. 19, 1933, pages 78-79; Mar. 5, 1933, pages 103-104. After general theoretical remarks on deoxidation of non-ferrous metal melts the various metals and alloys used for this purpose are considered. They have to meet the following requirements: (1) the heat of combustion of the deoxidizer must be considerably larger than that of the metal to be deoxidized, (2) a small excess of the deoxidizer should have no impairing effect on the properties of the deoxidized alloy, (3) the oxide formed must slag easily. With reference to these points the deoxidizing properties of Mg, Al, Si, Mn, Zr, P, C are discussed. The deoxidation of the most common alloys, the oxides appearing and their elimination are reviewed, as Cu-Zn alloys, Cu-Sn alloys, Cu-Zn-Sn alloys, pure Cu melts, Cu-Ni alloys, Cu-Ni-Zn alloys, Cu-Al alloys, Mn-Cu alloys, Cu-Si-Zn alloys, special brasses, Al and Al alloys. In all cases it is shown that for avoiding oxidation of the metal it is necessary to carefully cover and carefully melt the bath. To eliminate oxides formed the addition of the deoxidizers discussed is sufficient. GN (12a)

Deoxidizers For Brass Alloys. Charles Vickers. *Foundry,* Vol. 60, Dec. 1932, pages 20-21, 53. P, Mn, Al and Si are elements used chiefly as deoxidizers for brass and bronze alloys. Each element may be used either for alloying or as a deoxidizer. P is largely used in manufacture of red and yellow brasses. VSP (12a)

The Melting of Aluminum by Electricity. Geo. Turner. *Metal Industry,* London, Vol. 41, Dec. 16, 1932, pages 583-584. Russ-type furnace for melting and remelting Al is described, temperature control prevents overheating and keeps temperature at about 820° C. Hearth-type and crucible furnaces from 60 to 400 lbs. capacity are made. Ha (12a)

Manufacture of Cast Iron in the Rotary Pulverised Fuel Furnace. P. M. MacNair. *Foundry Trade Journal,* Vol. 47, Nov. 10, 1932, pages 286-288, 292. High temperatures involved in operation of a rotary furnace with pulverized coal facilitate slag operation and give a uniform product. Composition of iron is readily controlled. Melting cost including labor, depreciation, etc. compares favorably with cupola. OWE (12a)



Are You Keeping
Up-to-date on Modern
Melting Practice?
The Abstracts tell
what is going on.

Liquation as a Metallurgical Process and Equipment for It. (Das Seigern als metallurgische Operation und seine Hilfsmittel.) Max Moldenhauer. *Metall und Erz,* Vol. 30, Mar. 1933, pages 81-84, 103-112. Purpose of liquation processes is to separate alloys or mixtures into their constituents and isolate one or more of them. They cannot be used to separate eutectics or chemical compounds. They are especially suitable when there is a big difference in the melting point of the constituents. Three types of alloys or mixtures can be separated: 1. The 2 metals are insoluble in each other in both liquid and solid state, for example Fe-Pb. They do not alloy and all Pb can be melted off except 2-3% which is held by surface tension. 2. The two metals are slightly soluble in both liquid and solid state, such as Pb-Zn. When separated by liquation the resulting Zn contains some Pb and the Pb some Zn. 3. The two metals are slightly soluble in the liquid state, such as Zn-Fe. An alloy, probably a chemical compound, of Zn with 10% Fe is formed. When Pb-Zn-Fe mixtures are melted three layers form. The top is Zn containing a little Pb, the middle spongy Fe and Zn, and the bottom Pb containing a little Zn. It is best to liquate these mixtures by raising the temperature. Pan, kettle and furnace processes are used. In fuel fired furnaces the low temperatures and close control which are necessary are difficult to obtain. Too much oxidation of the metals from the hot air takes place. Electric furnaces overcome these difficulties, have low operating costs, and produce better separations. Pb-Sn alloys can be separated into eutectic, Pb, and Sn, but the process is not important commercially. From hypo-eutectic Pb-Ag alloys eutectic containing 2.5% Ag can be obtained by liquating. Hyper-eutectic Pb-Ag alloys do not separate according to theory, but form an alloy of Ag and eutectic. Pb-Sb alloys containing less than 8% Sb should be treated by the Pattinson process, those with 8-26% Sb should be liquated in a furnace, and those with more than 26% Sb in a kettle. In general, if the eutectic exceeds the other constituent, the alloy should be liquated under rising temperature. If the metal with the lowest freezing point is heavier and predominates, the alloy should be liquated under falling temperature and the Pattinson process used. A furnace for liquating under falling temperature is described. It has a deep hearth and is oil fired. Several other examples of separating by liquating are described. CEM (12a)

Melting Losses in the Cupola Furnace—Manganese. Colin D. Abell. *Foundry Trade Journal,* Vol. 47, Nov. 17, 1932, page 305. Experience has shown that only by using a low hearth-temperature and a relatively high content of alumina and magnesia in the slag can irons be made possessing the qualities of the cold-blast irons. It was found that the Mn distributed itself in such proportions that the percentage concentrations in the molten slag and iron were approximately equal. In charcoal practice the concentration of the Mn in the slag is twice that in the iron. The use of synthetic slags composed, for example, from dolomite and bauxite makes it possible to eliminate S and prevent the loss of Mn. OWE (12a)

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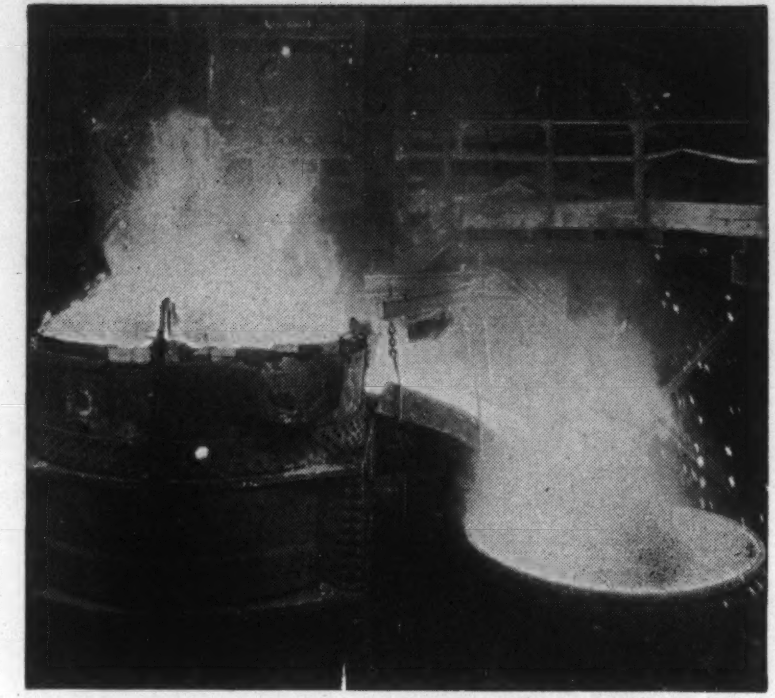

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Desulphurization of Cast Iron and Action of Sodium Carbonate on Molten Cast Iron. (Contribution à l'Étude de la Désulfuration de la Fonte et de l'Action de la Soude Carbonatée sur la Fonte en Fusion.) L. F. Girardet & R. Lelievre. *Bulletin de l'Association Technique de Fonderie,* Vol. 16, Aug. 1932, pages 467-475. Paper at World Foundry Congress, Paris, Sept. 1932. $Fe + Na_2CO_3 = FeO + 2Na + CO_2$; $Fe_3C + Na_2CO_3 = 3Fe + 2Na + CO_2 + CO$; $2C + Na_2CO_3 = 2Na + 3CO$. Metallic Na formed is extremely active and tends to vaporize at the temperature of the molten cast Fe. Na_2CO_3 added in a gyratory forehearth gives best results due to intimate mixture. Metallic oxides are reduced by the Na. Cupola slag and Na slag react in the ladle to free S which enters the cast Fe. Mn_3O_4 will also tend to prevent desulphurization. 28 references. WHS (12a)

Stainless Production; Equipment and Method of Manufacture. E. C. Smith. *Blast Furnace & Steel Plant,* Vol. 20, June 1932, pages 497-500, 509; July 1932, pages 593-595; Aug. 1932, pages 652-654; Sept. 1932, pages 715-717. Paper read before the American Iron & Steel Institute, May 19, 1932. See *Metals & Alloys,* Vol. 4, Aug. 1933, page MA 261. MS (12a)

Cupola vs. Electric Melting of Gray Iron in a Specialty Foundry. E. A. Wise. *Metals & Alloys,* Vol. 4, June 1933, pages 75-78. The author has found that the electric furnace fits the needs in melting specialty gray Fe where requirements vary from day to day better than the cupola. Melting 50% borings, the cost is less for electric furnace by $2.00 per ton. The quality of high test Fe is much better and easier to control. Standard mixtures and physical properties of cupola and electric furnace Fe for various types of castings are tabulated. Some instances of steel replaced by high strength cast Fe are illustrated. The melting practice is described. WLC (12a)

The System Iron-Iron Sulphide-Manganese Sulphide-Manganese. (Das System Eisen-Eisensulfid-Mangansulfid-Mangan.) R. Vogel & H. Baur. *Archiv für das Eisenhüttenwesen,* Vol. 6, May 1933, pages 495-500. The samples were melted under N_2, Mn being added to Fe-S alloys as the latter were more fluid than Mn-S alloys. Alloys up to 30% S and 35% Mn were studied. Two diagrams of the system Fe-FeS-MnS-Mn are shown as well as several sections through these diagrams. According to these diagrams, in steels containing S and Mn the S is mainly combined with Mn, and the structures would indicate that MnS, contrary to FeS, does not cause brittleness. SE (12a)

Desulphurization of Steel in the Coreless Induction Furnace throngh Alkalies. (Die Entschwefelung von Stahl im kernlosen Induktionsofen durch Alkalien.) H. Siegel. *Stahl und Eisen,* Vol. 22, June 22, 1933, pages 646-652. By means of alkaline slags it was possible to desulphurize 20 kg. melts of steel in an induction furnace from a content of 0.05% to 0.02% S. A. slag must be prepared which will dissolve Na_2CO_3 and S; such a slag was obtained by adding sodium silicate. SE (12a)

Use of Acid Electric Furnaces in Steel Foundries. (Applications en fonderie d'acier des fours électriques acides.) R. Lemoine. *Bulletin de l'Association Technique de Fonderie,* Vol. 16, Aug. 1932, pages 361-364. See *Metals & Alloys,* Vol. 4, Sept. 1933, page MA 294. WHS (12a)

Basic Bessemer Practice in France. *Engineer,* Vol. 154, Dec. 23, 1932, page 646. Summary of article in *Revue de Métallurgie* by F. Bicheroux entitled "A New Process for the Dephosphorization of Pig Iron in the Basic Converter." See *Metals & Alloys,* Vol. 4, Oct. 1933, page MA 323. LFM (12a)

An Open-Hearth Furnace for Melting Cast-Iron Borings. T. L. Joseph & C. E. Wood. *Foundry Trade Journal,* Vol. 47, Aug. 25, 1932, page 114. See "The Open-Hearth Furnace as a Means of Recovering Cast Iron from Borings," *Metals & Alloys,* Vol. 4, Oct. 1933, page MA 323. OWE (12a)

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Casting & Solidification (12b)

Die Casting Handbook. (Handbuch der Spritzgusstechnik.) LEOPOLD FROMMER. Julius Springer, Berlin, 1933. Cloth, 6½ x 9¼ inches, 686 pages. Price 66 RM. In the "Zeitschrift fuer Metallkunde," Vol. 17, 1925, No. 8, and "Werkstattstechnik" 1926, Nos. 4 and 6, two articles by the same author were published remarking that they are parts of a book which will soon be available. Part of these articles, which the reviewer translated at that time, aroused considerable interest among the members of the Die Casting Committee of the A.S.T.M. Still we had to wait another 7 years for the final appearance of the book. The author is to be congratulated on the outcome.

The die casting industry has always been surrounded by an atmosphere of secrecy which in many cases may be explained in the manifold problems dealt with and the difficulty of solution. Those who have worked on the steady development of this industry will find most of this development of the last few years compiled in the book and in addition the results of the effort to find a scientific solution to explain the complicated streaming conditions of the molten metal in the steel die. This is the contents of the first chapter.

To clarify this chapter, all necessary formulas are developed in a separate chapter, Chap. 8. The results of this study may be summarized in short: To produce the best possible castings, the molten metal has to enter the die with a minimum velocity. In the die the metal has to be under a certain pressure and fill the cavity of the die in such a way that all air present may escape. The velocity of the incoming metal and the pressure inside of the die are dependent upon the alloy and the temperature of the metal-bath. Considering one alloy, increased pressure decreases the necessary metal bath temperature permitting lower die temperatures resulting in longer die life.

The 2nd chapter deals with the die casting dies and their best way of building in regard to alloy, gating, venting, etc. Side and central gate dies are critically compared.

Chapters 3, 4 and 5 bring in about 280 pages on old and new types of die casting machines, classifying them as—(a)—machines with a hot pressure chamber, (b)—machines with a cold pressure chamber.

To the first group belongs the generally known plunger and gooseneck machines for the usual zinc and aluminum die castings. The second group are mostly used for brass castings. Their increasing importance is not quite realized here as yet.

The upkeep of this type of machine is also lower as the replacement of parts is less.

Chapter 6 deals with Sn, Pb, Zn, Al, Mn and Cu alloys, usable for die castings. The subject, mechanical inclusions in castings and metal bath like insoluble oxides, slags, reactions with the atmosphere and the influence of the compressed air on the molten metal, is discussed and explained. Shrinkage and grain size conditions through rapid chilling and aging are dealt with.

Many data in this part of the book are taken from the published work of the A. S. T. M. Committee B-6 on Die Casting. Of new and special interest are data on page 598 on Al alloys of the silumin beta type (12% Si, .5% Mn, .3% Mg, balance Al) and the K. S. Seawater alloy which are castable without iron pick-up on the machine with a cold pressure chamber. Also the Mg alloy "Elektron" and Cu alloys containing from 58% to 82% Cu are dealt with.

The 7th chapter deals with the finished casting, concerning the appearance, uniformity, size, micro and macro-structure, physical properties, etc.

Here again most interesting are data on castings (test bars) giving physical properties by different casting pressures. It is shown that impact and tensile strength increase with increasing pressure and the grain size decreases with higher pressures; giving castings of greater density. Similar experiments have been made in the last years in quite a number of places in this country and it is to be hoped that in the near future some of these results may be published. The same applies to the data on test bars, made of Cu alloys. The only papers on this subject in this country are by Charles Pack: "Press Casting," *Metals & Alloys*, Vol. 3, Feb. 1932; "Die Casting Brass and Other Alloys," *Metal Progress*, Vol. 20, July 1931.

In a short review (and this one is already longer than I expected), I am afraid full justice can not be given to the author of such a voluminous book. When in the following lines I am attempting to criticize some of the shortcomings as I see them, it is well to recall that this is to be taken as my personal opinion and mostly given as suggestions.

As far as theories are concerned, long years of tests on test bars and castings and information out of the field, will have to prove many of them (on our accelerated tests like steam tests, salt spray tests, etc., we still have not enough data on hand to find a correlation between happenings in actual service and short-time tests).

Dr. Frommer calls his book "A Handbook for Die Casting Practice." As such, it also should contain chapters dealing with matters specially developed for die casting purposes. Thus a chapter on polishing, cleaning and plating of die castings in Zn and Al alloys, also the coloring process for anodically treated Al castings would be very desirable. Information on these subjects is available in some technical pamphlets of the New Jersey Zinc Company and Aluminum Company of America.

The best methods of analysis for the foundry and finished castings in Al and Zn alloys, etc. for impurities like .006 Pb, .005 Cd, .001 Sn, .06 Mg, etc. in alloys should be given, (Chemical Analyses-Spectroscope.)

Again a pamphlet of the New Jersey Zinc Company's on Chemical Analyses of Zinc-Base Alloys may be mentioned and a paper of the Aluminum Research Institute on "Standard Methods for the Sampling and Analyzing of Aluminum and Certain Aluminum Alloys" will be of interest.

The literature used and referred to only in footnotes would be better placed in a bibliography at the end of the book.

On page 150, replacing of surface cracked dies and parts of same seems to be the only possible way out. Here atomic hydrogen welding is often a great money-saver.

On page 154, a reduction of surface friction is possible by chromium plating the die before heat-treatment, gaining also a complete avoidance of scaling without packing.

On page 156, recommending nitro-alloy steel for dies, it should be mentioned that only the mixture containing AlMo is usable for die casting dies and that the possibility of denitriding and renitriding is absolutely the main point. (See Merten's patent and also "Spot Softening A Nitrided Case" by Ashdown, American Machinist, May 24, 1933).

In Table 12 on page 520 and Tables 11 and 12 on pages 528 and 529, the newly developed Zn base alloys by the New Jersey Zinc Company which are now over 1½ years in practical use are missing. The properties of these alloys make it unnecessary to still bother with zinc base alloys containing tin.

Page 621, Table 24, Pressures of 50 and 25 should be reversed in the respective columns.

Page 642. The interesting studies on use of X-rays on die castings by Fink and Archer, A. S. S. T., Vol. 16, 1929, page 551 and Ancel St. John and Isenburger, A. S. S. T., Vol. 29, Part I, 1929, page 195, and the *Iron Age*, Vol. 125, 1930, No. 16, would have been worthwhile to mention.

In conclusion, we can pay no higher compliment to this book than to say we wish a similar book were available in the English language and a translation, therefore, would be most desirable.

F. J. Tobias (12b) -B-

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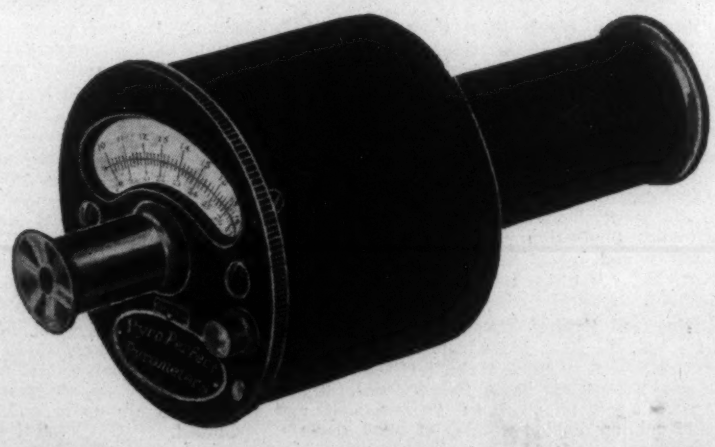

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Rolling (12c)

A Specialized Mill Practice for the Stainless Steels. E. R. Johnson & R. Sergeson. *Metal Progress,* Vol. 22, Oct. 1932, pages 21-27. Abstract of a paper for the Buffalo Convention, A. S. S. T., Oct. 1932. Mill practice in the Central Alloy District is described. The special care and frequent cleaning operations necessary in stainless steel strip production are due to the hardness of the material and the nature of the trade demand for it. Because of the continually increasing acceptance standards, methods of manufacture will continue to change frequently. WLC (12c)

Electric Induction Roll Heater. Kenneth Younghusband. *Rolling Mill Journal,* Vol. 7, No. 2, 1932, pages 89-92. Describes solenoid type. MS (12c)

Nikopol Pipe Mills. N. P. Besklubenko. *Domez,* No. 10, 1932, pages 13-20. In Russian. Plans and estimates of a pipe rolling plant to be built. (12c)

Keep Up With Modern Rolling Mill Practice

For cold rolling watch also Section 12j "Cold Working."

The Abstracts will help you

Roll Pressure Measurement by a Watt Meter (Walzdruckablesung am Wattmeter) L. Weiss. *Zeitschrift für Metallkunde,* Vol. 25, Apr. 1933, pages 98-99. Equations and graphs for deriving roll-pressure from power consumption in a four-high rolling mill. RFM (12c)

Roll Pass Design for Quality Steel Shapes. F. L. Panasenko. *Domez,* No. 1, 1933, pages 29-46. (In Russian.) With demand for close limits presented by tractor manufacture usual Russian rolling limits (within 3% of dimensions specified) were not satisfactory. Comprehensive analysis of steel and rolling practice indicated that exceptional amount of rejections was caused by improper pass design and misadjustments of rolls and not by steel used. (12c)

Roll Turning and Roll Design. Philip Robinson. *Proceedings Staffordshire Iron & Steel Institute,* Vol. 47, Session 1931-32, pages 24-38. It is attempted to deal with this subject from the practical point of view. After a general review of the development and classification of rolls, roll turning lathes and roll turning are discussed in detail. Methods of rolling squares, rounds, angles, and of spoke bars are given. The diagonal rolling as practiced in England, France and in Belgium is generally reviewed. GTM (12c)

The Use of Small Roll Diameters and Development of Multiple-Roll Mills. W. Rohn. *Metallurgia,* Vol. 7, Dec. 1932, pages 47-48. Extended abstract of an article in *Stahl und Eisen.* See *Metals & Alloys,* Vol. 4, June 1933, page MA 185. JLG (12c)

Electric Preheating of Hot Rolls in Sheet Mills (Das elektrische Vorwärmen der Warmwalzen in Feinblechwalzwerken) Rose. *Technische Blätter der deutschen Bergwerkszeitung,* Vol. 23, Aug. 13, 1933, pages 439-440. After discussing former methods of preheating hot rolls of sheet mills electric roll heater built by Freyn Engineering Co. is described, advantages over former methods are considered. Experience shows that number of roll fractures is considerably decreased in using Freyn preheater. GN (12c)

Electric Drive Winds Strip Under Constant Tension. C. L. Peterson. *Steel,* Vol. 91, Aug. 15, 1932, pages 24, 26. Description of new constant tension drive for winding strip steel. The usual clutch is replaced by a voltage regulator which preserves constant torque with changing reel diameter. To provide for variable speeds of main mill, reel is synchronized to main drive. JN (12c)

Technical and Practical Development of Mannesmann Tube-Rolling Process (Die technische und betriebwirtschaftliche Entwicklung des Mannesmannrohr-Walzverfahrens) R. Mooshake. *Stahl und Eisen,* Vol. 53, May 11, 1933, pages 465-468. The first patent on the Mannesmann process was granted in 1885. An account is given of the developments since then with illustrations of the latest 1933 Mannesmann rolls. Production costs have steadily decreased. Where formerly small tubes required several reheatings now much larger tubes are rolled with only a single heating. Through the use of alloy steel the life of mandrels has increased as much as 10 fold. SE (12c)

Forging and Rolling Temperatures of Steels. J. H. G. Monypenny. *Metallurgia,* Vol. 7, Mar. 1933, pages 147-150; Vol. 8, May 1933, pages 11-14, 18. Steels are easier to work at high temperatures but resulting properties are inferior to steels worked at lower temperatures. Finishing temperature is of great importance. Correct temperatures for working C and alloy steels are given, and some valuable pointers on hot-working of alloy steels are included. JLG (12c)

Evolution of the Sheet Steel Industry. W. H. Melaney. *Blast Furnace & Steel Plant,* Vol. 21, Jan. 1933, pages 28-31. Traces developments in American practice of rolling sheet steel and discusses modern methods. MS (12c)

Forging (12d)

Forging. Vol. I, Theory of Forging. S. V. Poretzki. Gosudarstvennoe Naouchno-Tekhnicheskoe Izdatelstvo, Leningrad, 1932. Paper, 5¾ x 9 inches, 207 pages. Price 4 roubles. Prof. Poretzki placed before himself the problem of presenting the theory and practice of forging as it is seen through the eyes of the best men all over the world. Many books are already available treating the main subdivisions of the question, its theory, tools and practice, quite often very well, but not one of them adequately covers all three. In this book an attempt is made to fill this gap.

The book under review is the first volume of the series and deals with the theory of forging. It starts with a general description of the properties of steel, dwells on the quality of ingots as viewed from the forging standpoint, briefly presents different types of steel, gives over a hundred pages to the theories of plastic deformation and ends with the methods for calculating the variables entering forging processes. Scientific chaff is scholarly separated from the wheat and discarded. Facts and ideas from the oldest to the most modern are recorded when they deserve it. An immense amount of material had to be examined critically before its substance could be incorporated in this comparatively small book.

Finishing the last page brings with it a full and vivid conception of the theories on which forging is based. The first volume sets a high mark for the following to attain. The sooner it is translated the better, because the book must be recommended to all interested in hot working of metals. (12d) **-B-**

Machining (12g)

Hard Metallic Carbides and their Uses. (Hochschmelzende Hartstoffe und ihre technische Anwendung.) Karl Becker. Verlag Chemie, Berlin, 1933, Cloth, 6x8½ inches, 227 pages. Price 21 RM. The various methods of formation of the carbides and nitrides of W, Ta, Mo, Ti, Zr, V, Nb and Hf and the properties of the compounds are briefly described. 134 patents on the preparation and bonding of the materials are briefly abstracted.

The practical application of such materials, especially of the German product Widia, as cutting tools, is discussed, and brief comment made on other applications, as in wire drawing dies.

Many people are vastly interested in the subject of this book and such people will find much of value in the volume. Published information is summarized but a great deal of unpublished information that is known to many but is still more or less of a trade secret among the elect remains to be recorded, so the volume is by no means the last word on the subject.

The author has confined himself chiefly to sintered tools and has not dealt with welded-on overlays for wear resistance.

On the whole, the average reader will expect, from the title, more information than he will get from the book. It reads rather too much like trade literature in places. Nevertheless, it will be welcomed in many quarters for collecting in convenient form considerable fragmentary information. H. W. Gillett (12g) **-B-**

Machining Problems (Problemes d' Usinage). *L'Usine,* Vol. 41, Nov. 11, 1932, pages 29-31; Nov. 18, 1932, pages 27-29. Preparation of jigs, tools and auxiliary equipment for hot working under the press. Ha (12g)

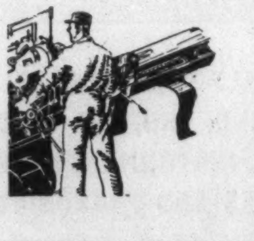
Chromium Plated Tool Tips. (Verchromung von Werkzeugschneiden.) *Schweizerische Technische Zeitschrift,* Vol. 30, Mar. 2, 1933, page 130. Cr plated tool tips are particularly suitable for machining light metals. Surface is essentially smoother, parts are closer to dimensions, and such tips are much more durable, as tests on reamers, files and drills show. GN (12g)

The Application of Carbide-Alloy Tools to Turret Lathes. George M. Class. *Machinery,* Vol. 38, May 1932, pages 671-672. Few changes in design of turret lathes are required for carbide-alloy tools. Vibration must be guarded against. Bearings and gears may have to be changed in some cases. Results of tests made in machining steel on turret lathes using new cutting alloys. RHP (12g)

Machining Motor Car Differentials. *Iron Age,* Feb. 18, 1932, pages 436-439. Describes some of the operations in a typical modern differential shop. Accuracy and attention to details is of importance in manufacturing this specialized mechanism with mass production methods. The company whose practice is described uses S.A.E. No. 2315 steel for the principal parts of its differentials. VSP (12g)

Piston Manufacture. *Automobile Engineer,* Vol. 22, Nov. 1932, pages 549-553. Describes methods employed in production of Sunbeam composite piston. Piston is made up of 2 parts, a head that is machined from an Al alloy die casting. The skirt is machined from a tube of case-hardened steel. Deals almost exclusively with machining processes and tools. Hardening processes are mentioned but not described. Does not give composition of alloys used. RHP (12g)

The Economic Use of Cemented Carbide and Other High-duty Alloy Tools. E. W. Field & J. H. Garnett. *Machinery,* London, Vol. 41, Oct. 20, 1932, pages 61-65; Oct. 27, 1932, pages 97-100. Paper read before Institution of Production Engineers, Birmingham. Present-day cutting materials are discussed and question is raised when and where a certain tool material can be used to best advantage on various materials. Cutting tool materials include cemented-carbide alloys (tungsten-carbide alloys, molybdenum-titanium alloys), Stellite (Co-Cr-W alloys) and some high-speed steels. In 4 tables comparative costs concerning use of high-speed steel and tungsten-carbide tools are recorded. Tables V and VI give particulars and savings effected on lathes using tungsten-carbide tools on cast iron, steel and gunmetal. Kz (12g)



Have You a Machining Problem?

The answer may be here.

Carbide Cutters for Face Milling. F. W. Curtis. *American Machinist,* Vol. 77, Jan. 4, 1933, pages 9-11. Tables developed from tests over 3 years are reproduced showing the best speed for cutting and feeding in face-milling different metals by tungsten carbide tools. General remarks on the best use of these tools are added. Ha (12g)

Milling with Carbide Insert Cutters. Frank W. Curtis. *Machinery,* Vol. 38, May 1932, page 685; June 1932, pages 749-752. Deals with advantages of carbide tools in milling. (1) Greater output due to higher speeds and faster feeds, and longer cutter life between grinds, (2) greater accuracy and improved finish, (3) less allowance is required for finish cut. Deals with costs and suitable practices. Second part considers grinding of W-carbide milling cutters, and the milling of Al, cast Fe and steel. RHP (12g)

Climb Milling for Faster Cutting, Greater Accuracy and Longer Tool Life. A. C. Fulton. *Mechanical Engineering,* Vol. 54, Oct. 1932, pages 692-694. Climb milling is called the reverse turning direction of the miller, that is, milling with the feed instead of against it as normally and starting to remove metal from outside into cut so that greatest stress on tool is at beginning of cutting stroke. Advantages are said to be greater cutter life and less time used for regrinding, and therefore more accurate work due to fewer set-ups. Further, heavier cuts can be made and better finish secured. Ha (12g)

Machining Aluminum. W. B. Francis. *Metal Industry,* N. Y., Vol. 31, May 1933, page 158. General requirements for drilling Al are: high speed twist drill should be used, angle of point should be 140°, cutting edges should be keen and smoothed by stoning or honing, grooves or flutes be polished, twists of helix be double that for steel, i.e. helix angle be 47°, higher speeds and lower feeds than for steel be used with a flood of soluble cutting oil. Hardwood and Al drill more like each other than like steel. PRK (12g)

Machines and Operations in Making Rockne Motor Blocks. Rogers A. Fiske. *Iron Age,* Vol. 130, Dec. 15, 1932, pages 912-915, adv. sec. page 18. Rockne motors are machined on a straight production line which includes 45 stations. Describes automatic machines, conveyor handling cradles and clamping devices. VSP (12g)

Accuracy and Speed Maintained in Machining Buick Crankcase. Burnham Finney. *Iron Age,* Vol. 129, Apr. 7, 1932, pages 828-830, 844. Buick Motor Co. has 3 crankcase departments capable of turning out a total of 90 crankcases an hour. Machine tools are connected by roller conveyors. Describes the various operations. VSP (12g)

Drawing & Stamping (12h)

Tools for Deep Drawing in a Single Action Press. CHAS. F. HENDERSON. *American Machinist*, Vol. 77, Feb. 1, 1933, page 87. Describes and illustrates combination blanking and drawing tools for drawing just as deep in a single-action as in a double-action press. Ha (12h)

Deep Drawing with the Blank Holder Operated by Air Pressure. (Tiefziehen mit Druckluftfaltenhalter.) E. ACKERMANN. *Werkstattstechnik*, Vol. 26, Jan. 1, 1932, pages 4-5. Operating blank holders by air pressure makes variation of pressure possible which means less tension and less contraction in deep drawing. Thereby, better use is made of drawability of material resulting in deeper drawing and fewer drawing operations. RFV (12h)

Modern Copper Wire Drawing Machines. (Die neuzeitliche Kupferdraht- Ziehmaschine.) A. HERZ. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 22, Dec. 4, 1932, pages 648-649. Detailed illustrated description of modern German high speed Cu wire drawing equipment. Number of drafts, speed, lubrication, wire pointing devices, etc. are considered. GN (12h)

Huge Drawing Press. (Ziehpresse ungewöhnlicher Abmessungen.) MANGOLD. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 22, Nov. 27, 1932, page 627. Described hydraulic drawing press, largest in world, has recently been installed at a French steel plant. Built by Hydraulik Co., Duisburg, Germany. Seamless hollow bodies with 1450 mm. outer diameter and up to 8.5 m. length can be drawn with this press. Press is 40 m. long and weighs 560 tons. GN (12h)

Drawing of Double-Walled Hollow Bodies in one Piece. (Ziehen doppelwandiger Hohlkörper aus einem Stück.) H. OTTO SCHOLL. *Das Werkzeug*, supplement to *Maschinenkonstrukteur-Betriebstechnik*, Vol. 8, Oct. 10, 1932, page 119-120. Describes process of drawing double-walled hollow bodies for automobile brakes. Production cost can be decreased 60% by drawing rather than machining. GN (12h)

The Measurement of the Surface Temperature of the Metal During the Drawing of Wire. F. C. THOMPSON & H. G. DYSON. *Metallurgia*, Vol. 6, Oct. 1932, pages 191-192. The surface temperature of brass wire being drawn through a steel die was determined by making the die and the wire elements of a thermocouple. The temperature increases rapidly as the speed increases and then more slowly. Highest temperatures were observed with no lubricant, next highest with soft soap, and lowest with oildag. With oildag the temperature at a drawing speed of 49 ft./min. was 71° C., the wire being drawn from 0.071" to 0.0638". JLG (12h)

Pickling (12i)

Compression of Hydrogen in Pickling Steel. SCHNECKENBERG. *Heat Treating & Forging*, Vol. 18, Aug. 1932, pages 477-478. At the Kaiser-Wilhelm-Institut für Eisenforschung, the pressure within a sealed steel tube ¼" thick, used as a cathode in an alkaline solution for several months, was found to be 2500 lb./in.^{2} This increased pressure was due to diffusion of H_2. The high pressure caused by accumulation of H_2 at spots where there are non-metallic impurities accounts for the formation of pickling blisters on steel sheets. MS (12i)

Cleaning of Iron with Phosphoric Acid. (Das Reinigen von Eisenoberfläche mit Phosphorsäure.) *Der Maschinenmarkt*, Vol. 38, Jan. 18, 1933, page 8. Phosphoric acid is particularly appropriate for cleaning iron or steel because of its lack of any subsequent rusting or corrosion though it is hygroscopic. On this account, it must be cleaned off thoroughly if any painting or lacquering is to be done. Otherwise, durable painting would be impossible by the formation of fine film of moisture on the surface of the metal. RV (12i)

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CHEMICAL ANALYSIS (14)

The Development of an Electrolytic Method for the Determination of Inclusions in Plain-Carbon Steels. G. R. Fitterer, B. E. Sockman, E. A. Krockenberger, R. B. Meneilly, E. W. Marshall, Jr. & J. F. Eckel. *United States Bureau of Mines, Report of Investigations* No. 3205, May 1933, 70 pages. An electrolytic method for determination of inclusions of MnO, MnS, FeS, SiO_2, and Al_2O_3 in plain and low C steels is described and discussed in detail. The electrolyte is 3% $FeSO_4.7H_2O$ and 1% NaCl with a H-ion concentration of $10^{-3.2}$ when prepared and 10^{-7} after 3 hrs. of electrolysis. The inclusions indicated are insoluble in the electrolyte. Basic $Fe_2(SO_4)_3$ and $Fe(OH)_2$ precipitate during electrolysis for FeO and contaminate the residue; FeO can be determined in more acid solutions having automatically controlled H-ion concentrations. MnO is partially soluble when in contact with both the anode and the electrolyte. When MnO is combined with other oxide material such as FeO, SiO_2, AlO_2O_3, etc. this induced solubility of MnO is reduced, usually to 0. No Mn $(OH)SO_4$ is formed; $Mn(OH)_2$ probably forms, but does not precipitate. SiO_2 is not contaminated in steels containing up to 0.9% Si, since the residual Si apparently goes into solution as silicic acid, but does not precipitate as the gel. Al_2O_3, Fe and Mn aluminates and Al silicates (from steels partially deoxidized with Al) are entirely insoluble in the electrolyte. MnS may be separated from MnO using Na citrate, MnO being soluble. FeS is recovered entirely, but may best be determined as the difference between the total S and the S in MnS. 94 references. AHE (14)

Determination of Zirconium in Plain Carbon and Alloy Steels. Thos. R. Cunningham & R. J. Price. *Industrial & Engineering Chemistry, Analytical Edition,* Vol. 3, Jan. 15, 1931, pages 105-106. Zr is separated from other elements as the acid phosphate, which is converted to pyrophosphate by ignition. The method described in this article is applicable to any commercial steel. MEH (14)

Determination of Nonmetallic Inclusions in Plain Carbon and Manganese Steels. Iodine and Nitric Acid Extraction Methods. Thos. R. Cunningham & R. J. Price. *Industrial & Engineering Chemistry, Analytical Edition,* Vol. 5, Jan. 5, 1933, pages 27-29. Method is presented for determination of nonmetallic inclusions in certain steels. The method, which uses ferrous iodide solution for the solution of the steel, has been developed from procedure of Eggertz. Details are given. MEH (14)

Determination of Lead in Mixed Solder and White Metal Scrap. (Zur Frage der Bleibestimmung in gemischten Lötzinn und Weissmetallrückständen.) Wolfgang Boehm. *Metall und Erz,* Vol. 30, Feb. 1933, pages 47-48. The 2 commonly used methods have disadvantages, (A) A 10 g. sample is dissolved in HCl with addition of $KClO_3$ and filtered. The residue is fused with Na_2O_2, dissolved and added to the filtrate. An aliquot part is partly neutralized with NH_4OH, Sn, Cu, Sb and Pb are precipitated with H_2S, filtered and washed free from Fe. The precipitate is treated with Na_2S, filtered, and the remaining CuS and PbS dissolved in HNO_3. H_2SO_4 is added, the solution evaporated and $PbSO_4$ weighed. In the first solution $PbCl_2$ is apt to crystallize out and the sulphide precipitate containing SnS is difficult to wash. (B) A 10 g. sample is dissolved in aqua regia, H_2SO_4 added, evaporated to fumes, and tartaric acid added. After filtering the precipitate is returned to the beaker and treated with ammonium acetate and acetic acid to dissolve the Pb. An aliquot part is treated with H_2SO_4, evaporated to fumes, and $PbSO_4$ weighed. The filtration in this method takes a long time on account of the presence of Sn. A better method is proposed which is quick and does not involve any tedious filtrations. (C) The sample is treated with 50-60 cc. Br-HBr solution (1:7) and evaporated almost to dryness, more Br-HBr added and again evaporated. This volatilizes the Sn and Sb. 20 c.c. H_2SO_4 is added and the solution evaporated to fumes and filtrated. It filters easily on account of the precipitate being granular. It is then dissolved in ammonium acetate and filtered to separate from sand etc., and the Pb reprecipitated with H_2SO_4. CEM (14)

The Quantitative Separation of Aluminum from Iron. J. Haslam. *The Analyst,* Vol. 58, May 1933, pages 270-272. Solution of Al and Fe was heated to boiling, H_2S passed in for 10 min., 5.5 ml. concentrated NH_4OH added and the mixture heated for 20 min. H_2S was passed in for 5 min., 1.5 ml. of concentrated NH_4OH added and the mixture allowed to settle. The precipitate was filtered off and washed 5 times with ammonium sulphide tartrate wash water. After the filtrate and washings were boiled for 10 min., a precipitate of S appeared, but this disappeared with further heating. To the clear liquid (200 ml.), 10 ml. concentrated HCl and 1 drop of methyl orange solution were added, followed by concentrated NH_4OH solution, drop by drop, until the liquid was pale yellow; 2.5 ml. concentrated NH_4OH were added and the solution diluted to 350 ml. Hydroxyquinoline sulphate solution was added, drop by drop, with constant stirring, to this ammoniacal solution until the supernatant liquor was yellow, then 5 ml. more was added. The liquid was heated to 90° and stirred to coagulate the precipitate. After standing for 4 hr., the Al hydroxyquinolate was filtered off, washed, dried and weighed. AHE (14)

Simultaneous Determination of Sulphur and Carbon in Iron Melts and in Steel by Combustion. (Dosage simultané du soufre et du carbone dans les ders, fontes, et aciers par combustion.) G. Misson. *Chimie et Industrie,* Vol. 27, Special Number, Mar. 1932, pages 326-328. S is determined with an apparatus suggested by Dr. Holtman (*Stahl und Eisen,* Vol. 48, 1924). Determination of C is obtained subsequently in a special agitating apparatus which favors the complete absorption of CO_2 in spite of fact that gas travels rather rapidly through solution. MAB (14)

Determination of Cadmium. A Critical Study of the Evrard Method. Loren C. Hurd & Richard W. Evans. *Industrial & Engineering Chemistry, Analytical Edition,* Vol. 5, Jan. 15, 1933, pages 16-17. Authors point out, in their critical study of Evrard method, that use of allyl iodourotropine as a precipitant for Cd is not a reliable method because of solubility and adsorption errors. Interference of other metals is also indicated. MEH (14)

Determination and Separation of Cobalt as Cobalti-nitrosonaphthol Compound. (Bestimmung und Trennung des Kobalts als Kobaltinitrosonaphthol-Verbindung.) C. Mayr & F. Feigl. *Zeitschrift für analytische Chemie,* Vol. 90, No. 1/2, 1932, pages 15-19. Describes a procedure for very exact determination of Co in solutions to which H_2O_2 and acetic acid is added and the Co then precipitated by a solution of α-nitroso-β-naphthol. Ha (14)

A Volumetric Method of Determining Sodium. J. T. Dobbins & R. M. Byrd. *Journal American Chemical Society,* Vol. 53, Sept. 1931, pages 3288-3291. Rapid and accurate volumetric method of determining Na has been developed, in which Na is precipitated as Na Zn uranyl acetate, and U content of precipitate titrated by means of NaOH. MEH (14)

Electroanalytical Separations in Ammoniacal Fluoride Solutions. I—Separation of Copper from Arsenic and Antimony. N. Howell Furman. *Industrial & Engineering Chemistry, Analytical Edition,* Vol. 3, Apr. 15, 1931, pages 217-218. New procedure is described for electrolytic separation of Cu from As and Sb in ammoniacal fluoride solutions. Some qualitative observations are made upon rapidity of oxidation of trivalent Sb by persulphate under various conditions. MEH (14)

The Indirect Volumetric Determination of Sodium Based on the Reduction and Titration of the Uranium in Magnesium Sodium Uranyl Acetate. N. Howell Furman, Earle R. Caley & Irl C. Schoonover. *Journal American Chemical Society,* Vol. 54, Apr. 1932, pages 1344-1349. Technique for rapid indirect determination of U or of Na described. MEH (14)

HISTORICAL & BIOGRAPHICAL (15)

Operated For Nearly 100 Years. P. D. Forbes. *Foundry,* Vol. 60, Mar. 1, 1932, page 40. Historical description of Coltness Iron Co., Newmains, Lannarkshire, Scotland. The company was organized in 1836 for the production of pig Fe. VSP (15)

The Romance of Lead in Missouri. Chas. W. Cuno. *Industrial & Engineering Chemistry,* Vol. 23, Jan. 1931, pages 108-110. History of Pb mining and metallurgy in Missouri. In over 2 centuries of exploitation Missouri has contributed more than 1/3 Pb produced in United States and nearly 1/6 of the total Pb produced in world. MEH (15)

Retrospect. (Rückblick). W. Guertler. *Zeitschrift für Metallkunde,* Vol. 25, Jan. 1933, pages 1-3. A brief history of the founding of the *Zeitschrift für Metallkunde* and of the scientific work which has been published therein during the last 25 years. Twenty-fifth anniversary number of this journal. RFM (15)

Production of Puddled Iron. E. Holden. *Iron & Coal Trades Review,* Vol. 126, Feb. 10, 1933, page 231. Historical review and sketch of the development of the puddling process which was introduced in 1874. Modern puddling furnaces turn out about 560 lbs. of iron in an 8-hour shift; to produce 1 ton of puddled bars about 2 tons of coke are required. Labor turnover for puddled iron is as high as over 80%, one of the highest in the industry. Ha (15)

Notable Advance Made in Foundry Practice in the Last Ten Years. Herbert R. Simonds. *Iron Age,* Vol. 129, May 19, 1932, pages 1097-1099, adv. sec. page 20. Biggest factor contributing to general improvement in quality of castings has been the constant attention to small details which constitute the full science of manufacture of castings. Improved foundry technique includes use of jigs and templates, improved patterns and development of more thorough testing methods. Progress in metallurgy is one of the outstanding developments in foundry industry. Use of carbide tools lowered machining allowance. Castings are more uniform in tensile strength and reduction of concealed defects. Development of heat treating Al castings has increased the scope of application of Al. Cleaner ingot production in brass and bronze foundry work is also an important development. Demand for exceptionally high-grade gray Fe castings has increased and assurance of freedom from defects has been secured. VSP (15)

ECONOMICS (16)

The Non-Ferrous Metals in 1932. *Foundry Trade Journal,* Vol. 48, Jan. 26, 1933, pages 74-75. Summary of effect of tariff on prices of Cu, Sn, spelter and Pb. OWE (16)

Manganese Ore in South Africa. *Foundry Trade Journal,* Vol. 47, Dec. 22, 1932, page 383. Short survey of production of manganese ore at Postmasburg, S. Africa, and economic possibilities of further development. OWE (16)

Wabana Iron Ore for Great Britain. *Iron & Steel of Canada,* Vol. 15, Dec. 1932, pages 147-149. This supply of ore provides a possible source of raw material for Great Britain, now that reciprocal trading agreements have been made. OWE (16)

India's Modern Steel Industry. *Iron & Steel of Canada,* Vol. 15, Oct. 1932, pages 124-125. An account of large deposits of Fe and Mn ores now being developed in India and of methods employed by Tata Iron & Steel Company. OWE (16)

Immense Deposits of High Grade Iron Ore in Sierra Leone. *Iron & Steel of Canada,* Vol. 15, Nov. 1932, page 139. The Tonkolili hematite ore deposits are briefly described and discussed in the light of the British intra-Imperial trade policies. OWE (16)

Iron and Steel in 1932. J. H. Thompson. *Mining Journal, Annual Review No.,* Vol. 180, Feb. 11, 1933, page 13. 1932 world production of steel ingots and castings was about 49,000,000 tons, 58% less than 1929. Pig Fe output was 38,200,000 tons, 30% less than 1931 and 60% less than 1929. Great Britain and Russia were only countries to increase steel production. AHE (16)

Titanium. P. M. Tyler & A. V. Petar. *United States Bureau of Mines, Mineral Resources of United States, 1931,* Part I, Nov. 14, 1932, pages 83-87. Domestic production of Ti minerals was concentrated in 2 companies and production figures can not be divulged. The bulk of the ilmenite consumption is of imported ore. In 1931 imports increased from 24,973 to 33,440 short tons worth $144,951. This was all from British India. Rutile imports amounted to 2000 lbs. worth $189. AHE (16)

Cobalt in 1931. P. M. Tyler & A. V. Petar. *United States Bureau of Mines, Mineral Resources of United States, 1931,* Part I, Nov. 14, 1932, pages 71-73. A carload of Co-Mn ore shipped from Ala. in 1931 was the first domestic Co production since 1921. Development was in progress in 5 states. Imports of Co ore were 83,895 lbs. worth $8,453, as compared with 199,642 lbs. and $18,994 in 1930. Imports of Co metal for 1931 were 164,967 lbs. worth $254,520; 460,251 lbs. and $984,244 in 1930. Oxide imports were 321,891 lbs. worth $391,479; 425,881 lbs. worth $769,331 in 1930. Belgian Congo and Canada are the 2 chief sources. AHE (16)

Tantalum. P. M. Tyler & A. V. Petar. *United States Bureau of Mines, Mineral Resources of United States, 1931,* Part I, Nov. 14, 1932, pages 81-82. Domestic production of Ta was sharply reduced in 1931 by an almost complete lack of demand. Some 700 lbs. of columbite, worth $490, were reported mined as compared with 5100 lbs. in 1930. Imports of Ta ores were 6,288 lbs., worth $6,289. AHE 16)

Mercury in 1931. P. M. Tyler & H. M. Meyers. *United States Bureau of Mines, Mineral Resources of United States, 1931,* Part I, Dec. 19, 1932, pages 191-209. In 1931, consumption of Hg in the U. S. declined approximately one third from 1930. However domestic production increased 16% from 21,553 flasks in 1930 to 24,947 flasks in 1931, although the value declined 12%. Imports declined 85% from 3,725 to 549 flasks (98% compared to 1926), and stocks in bonded warehouse from 305 in 1930 to 88 in 1931. AHE (16)

Ores and Industry in the Far East. H. Foster Bain. Published by Council on Foreign Relations, Inc., N. Y., Second edition, 1933. Cloth, 6x9 inches, 288 pages. Price $3.00. While much of this book is written from the technical viewpoint of the geologist and mining engineer, and it is designed to answer the question as to what the potential mineral resources of the Far East really are, with a special chapter on those of Manchuria and Jehol, it tells a far broader tale, and one interesting even to the layman with no special knowledge of or interest in metals and minerals. It shows the dependence of modern civilization upon metals, the economic significance of quality of ores and their location in respect to fuel and transportation, and how the presence or absence of mineral resources affects the type of civilization of the locality.

The metallurgist who reads this will have a greater respect for the importance of his profession and a wider economic perspective.

It would serve as a text book of economics, or of geography, and should appeal not only to those directly interested in minerals but to the average reader of the National Geographic Magazine. H. W. Gillett (16)-B-

1933 Tin—World Statistics. Bound brochure issued as supplement to Tin, the monthly bulletin of the Anglo Oriental Mining Corporation, London. 4¼"x6⅝", 138 pages. Statistics of production, consumption, prices, etc., through 1932 and in some cases through February or March, 1933, are collected in handy form. Those interested in the economics of the tin situation will find it useful. H. W. Gillett (16)-B-

MISCELLANEOUS (20)

Blast-furnace Gas as a Boiler Fuel. A. F. Webber. *Mechanical World & Engineering Record,* Vol. 92, 1932. pages 288-290. See "The Generation of Steam from Blast-Furnace Gas," *Metals & Alloys,* Vol. 4, July 1933, page MA 229. Kz (20)

Weight of Sheet and Strip Steel for Flat Work. J. G. Wikoff. *Metal Stampings,* Vol. 5, Oct. 1932, pages 615-616. Tabulates weights in lb./ft.^{2} and thicknesses in fractional in. and decimal in. of wrought-iron and thicknesses in decimal in. of steel or ingot-iron for U. S. standard gage Nos. 0000000-38. MS (20)

Ford Recovers Steel Scrap by Dismantling Old Cars. E. F. Ross. *Steel,* Vol. 91, Oct. 24, 1932, pages 23-24, 26-27. Seventh and concluding article. Description of Ford "disassembly line" at River Rouge, Mich. Junked cars, at the rate of 200 every 8 hrs., are stripped of all salvagable parts on a slow moving double chain conveyor, engines are removed and torn down for salvage and remelting, all non-ferrous materials are reclaimed and the steel frames finally pressed into bales with a 1000-ton hydraulic press. These bales are remelted in a special new 400-ton open-hearth furnace. JN (20)

Why Ball and Roller Bearings Require Lubrication. Maurice Reswick. *Iron Age,* Vol. 129, Mar. 10, 1932, pages 608-610. Lubricants in ball and roller bearings serve the following purposes: (1) Reduce friction at point of sliding contact between ball roller and separator cage, guiding flanges, and in deformed contact area on races; (2) prevent corrosion by forming protective coating; (3) form seal which excludes dust, dirt and water; and (4) carry away and dissipate heat generated in localized friction areas. Characteristics required of lubricants are discussed. VSP (20)

Weight of Sheet and Strip Steel for Stampings. J. G. Wikoff. *Metal Stampings,* Vol. 5, May 1932, pages 349-350. Tabulates weights in lb./ft.^{2} and U. S. standard gage nos. for thicknesses in fractions of an in. or in decimal in. from .375″-.00859″. MS (20)

Hydrogen Over-Voltage on Mercury Cathodes in the Presence of Small Quantities of Platinum Metals (Wasserstoffüberspannung an Quecksilberkathoden in Gegenwart kleiner Mengen von Platinmetallen) I. Slendyk & P. Heasymenko. *Zeitschrift für physikalische Chemie,* Abt. A, Vol. 162, Nov. 1932, pages 223-240. Volt/amp. curves taken during simultaneous deposition of Pt and hydrogen show 2 current rises. The first corresponds to the liberation of molecular H due to the catalytic action of Pt-atoms. The second current increase corresponds to the deposition at the unaffected Hg-surface. Except rhodium and palladium, other metals of the Pt-group resemble the behavior of Pt. The notable catalytic hydrogen liberations are produced by traces of Pt (10^{-8} g./atoms/1000 cc.) EF (20)

Evolution of the Various Kinds of Lead (Zur Entstehungsgeschichte der Bleiarten) O. Hahn & L. Meitner. *Die Naturwissenschaften,* Vol. 21, Mar. 24, 1933, pages 237-238. Writers deny that the genesis of Pb_{207} must necessarily be different from that of Pb_{206} and $_{208}$. The various possibilities of the Pb origin are discussed. It is possible that the different elements of the earth have been formed at different times of the cosmic chronology. EF (20)

Weight of 18% Nickel Silver Sheets. J. K. Olsen. *Metal Stampings,* Vol. 5, Apr. 1932, page 274. Tabulates thicknesses in decimal in. and weights in lb./ft.^{2} for B. & S. gages from 0000-46. MS (20)

Carbides of Low Tungsten and Molybdenum Steels. F. R. Morral, G. Phragmén & A. Westgren. *Nature,* Vol. 132, July 8, 1933, pages 61-62. A carbide consisting of Fe_4C, with a little of its Fe replaced by W, was found in W magnet steels. In small amounts it is present in high-speed steels. In Fe-W-C-alloys low in W (2% W and 1% C) it seems to be the only carbide present, and in alloys containing still less W (1.5% W and 0.5-1% C) the new carbide occurs in mixture with cementite. It is also present in low Mo steels. No carbide of this kind has so far been met with in any Fe-C alloys. As the presence of W or Mo seems to be necessary for its formation, a small amount of these metals certainly enters the carbide. It seems correct to denote it by the formula $(Fe,W)_4C$ or $(Fe,Mo)_4C$, even if its W or Mo content amounts only to a few atomic percent. Kz (20)

On the Relation Between the Diffusion-Coefficients and Concentrations of Solid Metals. (The Nickel-Copper System). Chujiro Matano. *Japanese Journal of Physics,* Vol. 8, June 30, 1933, pages 109-113. The coefficient of diffusion D being considered as a function of the concentration c, Grube and Jedele's results with regard to the Ni-Cu system at 1025° C. were analysed by Boltzmann's method. The conclusion is that the value of above 8×10^{-5} cm.^{2}/day at $c = 0$ of Ni, D decreases rapidly to about 1×10^{-5} cm.^{2}/day at $c = 30\%$ of Ni and then keeps its value when c increases to 100% of Ni. Kz (20)

How Carboloy Tools are Made. Adam MacKenzie. *Machinery,* Vol. 38, June 1932, pages 727-730. Carboloy Co. takes care to assure uniformity of W. W and C are mixed, pressed and semi-sintered. At this stage the carbide is very workable. It is drilled, ground or shaped. Final sintering then takes place usually between 1350° and 1550° C. Discusses attaching of carboloy tip to steel shank. RHP (20)

Recovering Silver from Film Scrap (Wiedergewinnung des Silbers aus Filmabfällen) W. Graulich. *Technische Blätter der deutschen Bergwerkszeitung,* Vol. 23, Aug. 13, 1933, page 440. Brief description of a few new patented processes for recovering Ag of motion picture films. GN (20)

Weight Chart for Sheet Steel. Edward Heller. *Metal Stampings,* Vol. 5, July 1932, pages 465-466, 478. Presents chart for obtaining weight of sheet steel when dimensions are given in inches. MS (20)

Spontaneous Ignition of Metals (Selbstentzündung von Metallen) Freitag. *Oberflächentechnik,* Vol. 10, May 2, 1933, pages 107-108. Metals in very finely divided state are liable to spontaneous ignition on account of the very vivid oxidation with the oxygen of the air which takes place in this condition. This can occur even below 0° C. as in Pb for instance. Fe, Ni, Co and Mn and particularly light metals show this tendency to ignite. The so-called pyrophoric alloys are based on this phenomenon. Cases are known where the often used alloy of 86.2% Mg, 0.3% Si, 13.5% Cu (sp.g. 1.8) ignited spontaneously. The products of combustion are not poisonous. Extinguishing is usually difficult. Water must be avoided because of explosive oxy-hydrogen development. The best extinguisher is dry sand. Chips falling from the lathe during the working process are also liable to ignite. Al-foils and bronzes can also ignite by action of light (flash lamps). Some inexplicable fires of metal scrap can be explained by these facts. Ha (20)

Significance of Internal Stresses on Theory of Magnetization Curve (Die Bedeutung der inneren Materialspannung für die Theorie der Magnetisierungskurve) P. Freisach. *Elektrische Nachrichten Technik,* Vol. 9, Sept. 1932, pages 334-340. Discusses magnetization of single crystals, magnetization at the presence of elastic stresses and the role of internal stresses in commercial materials. The establishment of the anisotropic properties of the crystal lattice does not yield any clue regarding the phenomena occurring at low field intensities nor with respect to hysteresis properties. The theory of the distorted crystal lattice according to Becker (*Zeitschrift für Physik,* Vol. 62, 1930, page 253) throws light upon the behavior of ferro-magnetic materials at low field strengths. Experimental results on the magnetostriction of Fe and Ni single crystals according to Honda & Kaya and the writer's magnetization curves on Fe with 8% Ni submitted to tensile stresses are presented. With increasing stress, the ideal case of a rectangular loop has been approached. The initial permeability of commercial material can be evaluated according to Becker's formula. Large initial permeabilities can only be secured by careful annealing treatments and avoidance of contaminations. The permeability of Fe is particularly strongly affected by small amounts of contamination. EF (20)

FOUNDRY PRACTICE & APPLIANCES (22)

Processing Plaster of Paris Pattern for a Pulley. (Anfertigung eines Muttermodells aus Gips für eine Stufenscheibe.) F. Brobeck. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 54, May 14, 1933, pages 207-208. Detailed discussion of the procedure to be followed in making the pattern. GN (22)

Sand Testing in the Foundry. W. Y. Buchanan. *Foundry Trade Journal,* Vol. 48, Mar. 9, 1933, pages 171-173; Mar. 16, 1933, pages 191-192, 196. A description of some testing methods, using simple apparatus which can readily be built for measuring permeability, penetration, hardness, density, moisture, etc. OWE (22)

Aluminium Metallurgy. N. F. Budgen. *Foundry Trade Journal,* Vol. 48, Apr. 6, 1933, pages 241-243. Production of Al is summarized and casting processes for Al alloys are discussed under the headings: fluxes, gases in castings, corrosion, melting temperature, pouring temperature, soaking. OWE (22)

Further Notes on Oil-Engine Foundry Practice. Herbert E. Beardshaw. *Foundry Trade Journal,* Vol. 47, Dec. 29, 1932, pages 402-403; Vol. 48, Jan. 5, 1933, pages 5-6. Necessity for more consistent control and for more efficient handling of materials to eliminate waste are emphasized. Efficient methods of introducing metal to mold by runners, as well as proper design of gates, are described. Effect of chilling and of degree of dryness of mold is summarized. A simple method of calculating teeming speeds is given. OWE (22)

Plaster Patterns in General Foundry Practice. Robert Ballantine. *Foundry Trade Journal,* Vol. 47, Dec. 8, 1932, pages 351-353. For light casting work plaster of paris or stucco forms a convenient pattern-making medium. Fragility of material is a disadvantage, and research is still needed to solve many pattern-making problems which arise in its use. OWE (22)

Some Methods of Production in a Modern Malleable Iron Foundry. H. J. Beck. *Foundry Trade Journal,* Vol. 47, Dec. 1, 1932, pages 327-328. Melting in air furnaces and composition of furnace charges are mentioned. 3 types of machine molding and molding methods for malleable castings are summarized. Importance of feeding, methods of annealing, machinability of malleable castings and their physical properties are briefly discussed. OWE (22)

The Single-Cast Piston Ring in Green-Sand Molds. Colin Duncombe Abell. *Foundry Trade Journal,* Vol. 47, Dec. 29, 1932, pages 395-396. Description of "multiple-mold process" for mass production of piston-ring castings in green-sand molds. A convenient design of pattern plate is given, and most effective design of mold is discussed. Importance of a knowledge of effective chilling is illustrated from various points of view. There is a short note on alloy additions recommended. OWE (22)

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Foundry Education. J. H. Andrew. *Foundry Trade Journal,* Vol. 48, Mar. 16, 1933, pages 189-190, 196. A suggested curriculum for the study of founding problems and a description of some of the equipment which the teaching institution should possess. OWE (22)

Molding Sand. (Introduction a l'Étude des Sables de Moulage.) L. F. C. Girardet. *Bulletin de l'Association Technique de Fonderie,* Vol. 7, Feb. 1933, pages 43-58. Description of a "granulometric analysis" of molding sand by washing in a special apparatus. Favorable effect of heat on molding sand is to cause the allotropic modification of the silica; unfavorable effects are to cause fragmentation of the sand crystals and destruction of the bond. 24 references. WHS (22)

Casting of a Bronze Dome in Green Sand. (Das Giessen einer Bronzekuppel in nassem Sand.) Praktikus. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 53, Dec. 25, 1932, pages 518-519. Procedure of molding, core making, gating is described in detail. The dome, similar to a church bell, was cast of pure bronze containing 90% Cu and 10% Sn. GN (22)

Processing of a Trough with Frame and Sweep. (Herstellung eines Troges mittels Rahmen und Schablone.) E. Merz. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 54, Feb. 5, 1933, pages 59-60. Detailed, illustrated description of procedure to be followed in making patterns, molding, gating, arranging risers, etc. GN (22)

Foundry Mechanization. H. F. Coggon. *Metallurgia,* Vol. 7, Apr. 1933, pages 171-172, 174. Discusses mechanization with especial reference to British foundries. JLG (22)

Recent Development of Cast Iron in Germany. (Développement Récent des Fontes en Allemagne.) Gustave Meyersberg. *Bulletin de l'Association Technique de Fonderie,* Vol. 16, Aug. 1932, pages 378-384. German exchange paper presented at World Foundry Congress, Paris, Sept. 1932. Frequency curves are used to study and control results obtained by new processes. Quality of cast Fe is measured by product of tensile strength times the "bending index." The reaction temperature of the coke used in melting affects the carbon content of the cast Fe. Machineability, polishing, thermal stability, graphite nuclei, and superheating of cast Fe are discussed. 19 references. WHS (22)

Bushings in Red or Yellow Brass. (Buselures en Laiton Rouge ou Janne.) *Revue de Fonderie Moderne,* Vol. 24, Dec. 25, 1932, pages 468-469. Advantageous methods for molding, casting and stripping of small hollow articles are described. Ha (22)

Production of Cores by Manual Labor (Ueber Herstellung profilierter Kerne durch Handarbeit) Wilh. Schneider. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 54, Aug. 20, 1933, pages 340-343. The author describes and illustrates an efficient method for making insulating cap molds. According to an older method 3 single caps were molded in a flask causing poor utilization of pattern boards. Therefore, double cores were used thus making possible the arrangement of 4 patterns on a plate. In preparing these double cores, drying plates of core sand were used instead of the common iron ones. The new method resulted in a 33% increase of production, a decrease of wages and a saving of material. GN (22)

Explosion of a Cupola Blower (Explosion eines Kupolofengebläses) Emil Schüz. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 54, July 23, 1933, pages 297-298. Description of accident and causes. GN (22)

Cause and Effect in Bronze Founding. Francis W. Rowe. *Foundry Trade Journal,* Vol. 47, Nov. 10, 1932, pages 282-283, 292. See *Metals & Alloys,* Vol. 4, Oct. 1933, page MA 330. OWE (22)

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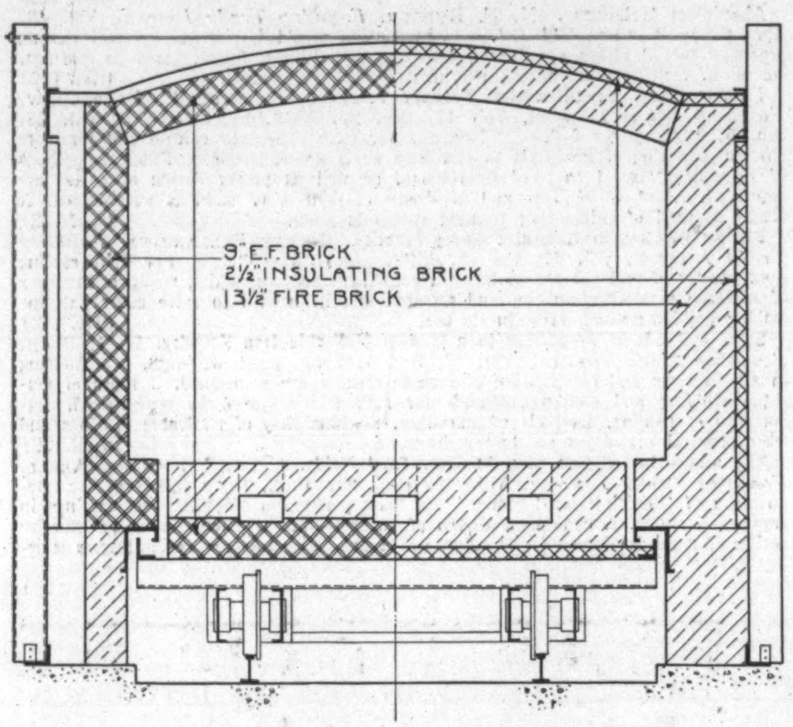

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FURNACES & FUELS (23)

Arrangement of Heating Elements in the Electric Resistance Furnace and the Determination of their Permissible Load. (Anordnung der Heizelemente im Elektrischen Widerstandofen und Bestimmung ihrer zulässigen Belastung.) R. Graenzer. *Elektrowärme,* Vol. 2, Oct. 1, 1932, pages 222-226. Analytical treatment of heat exchange between resistance and surroundings in furnace and of influence of furnace walls as a function of arrangement of heating elements. Ha (23)

New Development for Electric Furnaces. J. E. Oram. *Heat Treating & Forging,* Vol. 18, Nov. 1932, pages 654-655. Describes Wild-Barfield electric furnace fitted with a centrifugal fan. Described by A. J. T. Eyles in *Electrical Review,* Vol. 111, Dec. 9, 1932, page 848. MS (23)

Heating with Electricity (Sulla ricalcatura mediante riscaldimento elletrico). L. Losana. *La Metallurgia Italiana,* Vol. 25, Feb. 1933, pages 91-96. Because of skin-effect, heating with electricity using an a.c. current, gives uneven results in hardening, wire-drawing, etc. Attempts are being made to adapt d.c. current. AWC (23)

A New Automatic Hardening Furnace. E. Fr. Russ. *Engineering Progress,* Vol. 13, Apr. 1932, pages 81-82. Describes and illustrates Russ electric salt bath furnace manufactured by ''Industrie'' Elektroofen G.m.b.H. Cologne. Furnace comprises a metal trough of salt heated externally by electricity. Its operation is automatic. Temperature range is up to 900° C. Capacity 5,500 lb. daily of small parts. Current consumption 140 to 200 W./lb. of steel treated. RHP (23)

Development in Electric Furnaces. C. R. Copp. *Fuels & Furnaces,* Vol. 10, Jan. 1932, pages 59-64, 78. Recent developments in electric furnace heating; bright annealing, enameling, Cu and Al sheet annealing, and hardening are discussed and equipment described and illustrated. Ha (23)

Progress in Industrial Heating during 1932. R. M. Cherry. *Heat Treating & Forging,* Vol. 19, Jan. 1933, pages 15-16. Among electric furnace installations made were bell-type, continuous-type and pusher-type furnaces for bright annealing. 2 types of atmosphere-producing equipment and a furnace using immersion-type heating units were made. MS (23)

S. E. Heuland Electric Furnace for Steel Making. (Le four électrique S. E. Heuland pour la fabrication de l'acier) *Journal du Four Electrique,* Vol. 42, Feb. 1933, pages 60-62. Constructional details of furnace which does not have usual electrode holders. Electrode holders are mounted on a special triangular casting and consist of hydraulically operated water cooled cylinders. Many operating advantages are claimed. JDG (23)

Construction of Cupola Furnaces. (Der Bau und der Betrieb der Kupolöfen.) L. Schmid. Wilhelm Knapp, Halle (Saale), 1933. Paper 6¼x9¼ inches, 132 pages. Price 8.80 RM. This is part 1 of Vol. 20 of H. Hermanns' ''Die Betriebspraxis der Eisen-Stahl-und Metallgiesserei,'' and gives a very complete picture of German cupola design. Starting with a brief historical discussion of primitive furnaces, it turns to detailed discussion of shape, dimensions, lining, methods of supplying and regulating blast, gas offtakes and dust collectors, loading devices, tapping means, forehearths of all sorts, means of superheating cupola metal, as by oil or by an Ajax Wyatt furnace, and discusses many kinds of slag separating devices. Equipment used in desulphurization, shaking forehearths, hot blast, and the use of pulverized coal, oil or gas in cupolas also are dealt with.

While the book is concerned almost solely with German equipment, the discussion is broad and any cupola man will find it of distinct interest. H. W. Gillett (23)-**B**-

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Diffusion Combustion Heating Reduces Scaling Loss of Steel. Part I. W. M. Hepburn. *Steel,* Vol. 91, Sept. 5, 1932, pages 25-27; **Part II.** Sept. 19, 1932, pages 21-23. Diffusion combustion produces flame yielding maximum precipitation of free C. Adjacent and parallel streams of air and illuminating gas pass through the furnace and diffuse to form a continuous series of combustion mixtures. Flame is propagated at point of maximum C breakdown so that a layer of free C is deposited on the work. The raw gases may also blanket the work at the hearth level. These factors provide a definite protection against scale formation and, in case of forging furnaces, result in a 10% saving in die expense and a 1% saving in steel. The layer of free C prevents oxidation of polished steel forgings at 2400° F., prevents sheets heated in packs from sticking together, and offsets decarburizing effects in annealing. Ordinary luminous combustion cannot produce scale-free forgings. JN (23)

Diffusion Combustion, New Applications of Old Principles. W. M. Hepburn. *Metal Progress,* Vol. 22, Sept. 1932, pages 24-28. Difference between diffusion combustion and luminous combustion is discussed. Height or length of flame is proportional to velocity of air and gas, but independent of pressure or preheat, and area of gas and air ports if kept constant. "Overventilated" flame has a dagger shape, "underventilated" a bell shape. Diffusion combustion has nearly constant rate of radiation with maximum and uniform C precipitation, and preserves a constant flame temperature for its designed length of travel. A protective layer of sooty gas can be maintained over the work excluding O and reducing scale. Heating rate is increased over the luminous combustion rate, a lower furnace temperature with less maintenance cost and more accurate control and better surface condition of work are obtained with diffusion combustion. Applications and installations of diffusion combustion equipment are described and illustrated. The beneficial effect of free C is discussed. WLC (23)

High-Frequency Furnace in Theory and Practice for the Field of High Temperature (Der Hochfrequenzofen in Theorie und Praxis für das Gebiet hoher Temperaturen). W. Esmarch. *Zeitschrift für technische Physik,* Vol. 13, No. 12, 1932, pages 590-591. Physical characteristics of high-frequency furnaces and their manner of working is explained theoretically with particular regard to melting furnaces. Small laboratory furnaces can be built easily for 2500° C., while larger ones have not exceeded 1800°-2000° C. For sintering, temperatures up to 3300° C. have been obtained. The conditions for maximum efficiency were investigated and a formula developed for the radiation pressure causing movement of the melt (pinch effect). Ha (23)

Importance of Physical State of Materials Composing Fusion Bed for Working and Yield of Electric Furnaces. (Importance de l'état physique des matières du lit de fusion dans le rendement et la marche de fours électriques.) Ch. Louis. *Journal du Four Electrique,* Vol. 42, Feb. 1933, page 62. Generalities. JDG (23)

Melts Gray and Malleable Iron in the Electric Furnace. J. C. Bennett & J. H. Vogel. *Foundry,* Vol. 60, Feb. 1, 1932, pages 35-38. Abstract of paper read at the Chicago convention of the American Foundrymen's Association. See *Metals & Alloys,* Vol. 2, July 1931, page 135. VSP (23)

Coreless Induction Furnaces. R. N. Blakeslee, Jr. *Foundry,* Vol. 60, July, 1932, pages 18-19, 46. The furnaces have proven valuable because they reproduce analysis and structure of alloys and reclaim scrap, particularly Cr-bearing scrap, with low loss. Field of this furnace has been limited to melting of alloy steels, heat and corrosion resisting; high speed steel; plain C steel, cast Fe and bronze. Describes installations at Lebanon Steel Foundry Co., Babcock & Wilcox Co., Hoskins Mfg. Co. and Duriron Co. VSP (23)

Producing Steels and Alloys in Coreless Induction Furnaces. R. N. Blakeslee, Jr. *Steel,* Vol. 91, July 25, 1932, pages 23-25. Description of operation and power supply of a number of types of coreless induction furnaces used in foundry work. These are employed for melting Cr-Ni stainless steels, high speed steels, plain C steels, chromel alloy, Duriron, etc. A "lift coil" type of furnace for melting bronzes is described in some detail. Induction furnaces permit low scrap loss, great flexibility in operation, and high reproducibility of successive melts. JN (23)

A Simple Induction Furnace for Melting Copper Alloys. (Ein einfacher Induktionsofen zum Schmelzen von Kupferlegierungen.) E. Fr. Russ. *Metallwirtschaft,* Vol. 12, May 12, 1933, page 268. The furnace has a capacity of 100 to 300 kg., is shipped already assembled, and does not require any special foundation. The hearth is replaceable, similar to a crucible. When alloys of different compositions are to be melted, several hearths with different linings can be used. They are inexpensive and easily changed. One hearth is good for 1000 to 5000 heats. The current used for melting brass or bronze is about 25 Kw. hr./100 kg. and the melting loss is about 1 to 2.5%. CEM (23)

Electrical Characteristics of and Practical Considerations Regarding Electric Induction Furnaces. (Characteristiques électrique et considérations pratiques sur les fours électriques à induction.) *Journal du Four Electrique,* Vol. 41, Sept. 1932, pages 338-341. Abstract of paper presented by P. Bunet at the last International Electrical Congress. The present installment deals with general aspects of electrical furnaces. JDG (23)

The Inductive Heating of Metals. E. F. Northrup. *Fuels & Furnaces,* Vol. 11, Jan./Feb. 1933, pages 23-40. The principles of induction with special regard to its heating effect in ferrous and non-ferrous metals, equipment needed, coupling of circuits between inducing coil and induced body (susceptor) for attaining an efficiency as high as possible, and high frequency power generating plants are discussed and described. Examples from practice are given, and investment and operating costs are treated. Ha (23)

Heating Metals and Alloys Inductively Has Advantages. E. F. Northrup. *Electrical World,* Vol. 101, Feb. 25, 1933, pages 252-354. Abstract of paper presented before Pittsburgh section, Association of Iron & Steel Electrical Engineers. Practically all metals and alloys not directly cast require a reheating at some stage of their fabrication. Inductive electrical heating can meet the requirements in many of these processes. The general character of material which may be heated inductively may be summarized as follows: (1) metal pieces to be heated should have a certain symmetry of form; (2) large diameters are favorable to inductive heating; (3) magnetic metal is cheaper to heat than non-magnetic metal; (4) the ratio in economies of inductive heating to fuel heating increases with increase in the final temperature demanded; (5) for extremely fast heating the inductive method is unexcelled; (6) localized heating of a part of a large metal piece is most readily accomplished by induction (arc heating excluded). CBJ (23)

Induction Furnace of 3000° Absolute Temperature for the International Light Unit. (Ein Induktionsofen von 3000° Abs. für die internationale Lichteinheit.) *Technische Blätter der deutschen Bergwerkszeitung,* Vol. 23, Mar. 5, 1933, page 139. Induction furnace built originally for above purpose. Can be used to vaporize metals of very high melting point, such as W, for spectroscopic investigations and atom research. Furnace was developed by Physikalisch-Technische Reichsanstalt in coöperation with Siemens Co. GN (23)

The "Sesci" Melting Furnace. *Iron & Coal Trades Review,* Vol. 125, Sept. 2, 1932, pages 333-335. Principle of Sesci furnace is to melt metal in batches and using pulverized anthracite as a fuel, instead of by the continuous method in the cupola. Furnace is of rotary type and consists of a cylinder built up of steel plates lined with a high silica refractory rammed against steel shell. Installation and operation of such a furnace of 5 tons in the National Gas Engine Co., England, is described and illustrated in detail. The uniformity and quality of the castings is said to be superior to castings from the cupola furnace. Ha (23)

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NORTON REFRACTORIES

Providing Flexibility in Plant Gas Demands. *Steel,* Vol. 90, May 23, 1932, pages 30, 34. See "Flexibility in the Use of Blast Furnace and Coke Oven Gas in a Steel Plant," *Metals & Alloys,* Vol. 4, Aug. 1933, page MA 266. JN (23)

Small Coke-Oven Gas-Burners in the Iron Industry (Kleinverbraucher von Koksofengas in der Eisenindustrie) A. Herberholz. *Stahl und Eisen,* Vol. 53, Apr. 27, 1933, pages 417-422. Small coke-oven gas-burners can be used to advantage in steel plants for warming ground dolomite, drying sand and stopper rods, burning-in converter bottoms, warming molds and ladles, and for a variety of other purposes. SE (23)

Anthracite Gas For Heat Treating At Lower Cost. *Iron Age,* Vol. 129, Jan. 14, 1932, pages 176-178. Describes, with cost data, the operation of a producer burning No. 2 buckwheat anthracite and making anthracite gas developed by A. L. Galusha of Dover Boiler Works, New York. VSP (23)

The Development of Town Gas for Trade and Industrial Purposes. H. D. Madden. *Gas Engineer,* Vol. 57, Oct. 1932, pages 570-571. Paper before the Wales and Monmouthshire Association of Gas Engineers states that gas makes a strong bid for metal melting due to its flexibility, control of heat, provision of oxidizing or reducing atmosphere and absence of storage. WH (23)

Town Gas in the Tinplate Industry. *Mechanical World & Engineering Record,* Vol. 92, Sept. 9, 1932, pages 239-240. Main requirements for Sn-pot firing are quick heating from cold and correct and constant temperature throughout the pot. A saving of 47% has been made by the use of town gas, and a more uniform temperature maintained. Further applications are being made in mill furnaces and furnaces for annealing and normalizing. Kz (23)

Gas as a Fuel in a Large Galvanizing Plant. *Gas Engineer,* Vol. 57, Dec. 1932, pages 640-641. Details of modern installation of Canadian Bridge Co. with 2 galvanizing units each consisting of a 90 ton pot, 27 ft. 4 in. square. Pot is fired with gas, 9 burners on each side in such a manner as to prevent direct flame impingement on pot. Air is pre-heated by a recuperator. Average full load capacity of pot is 6 tons/hr. (10 maximum). One of most important features contributing to the low cost of operation is automatic temperature control which minimizes time lag of actuating instrument in response to full valve adjustments. WH (23)

Developments in Gas-fired Furnaces. J. Taylor. *Machinery,* London, Vol. 40, Aug. 18, 1932, pages 613-619. Describes an automatic controlled gas-fired furnace constructed by Gibbons & Co., Dudly, suitable for small manufacturers and which burns expensive city gas economically. Production and economical use of producer gas. An enamelling muffle furnace, a plate heating furnace, a furnace intended to heat large parts of metal, and the Wellman-Chantraine or "Multi-flame" furnace in every part of which the flame is produced in equal volumes, utilization of waste heat and heat balance of an average gas-fired furnace are described. Improvements mentioned are pressure burners and suspended roofs. Kz (23)

The Development of Gas as an Industrial Fuel. J. E. White. *Gas Engineer,* Vol. 58, Institution Special Number, June 1933, pages 319-325. Paper read before 70th Annual General Meeting of Institution of Gas Engineers, May-June 1933. In ship yards and allied trades, the use of oxy-coal gas cutting has been investigated and a modified form of cutting pipe developed capable of cutting at a speed equal to oxy-acetylene after penetrating the many coats of paint, rust, lime, etc. The cutting of 27 ft. 6 in. of ½ in. rusty ship's plate costs 14.34d. with oxy-acetylene cutting and 8.16d. with oxy-coal gas. On ⅜" plate a speed of 22"/min. is obtained readily. Service data are presented showing highly satisfactory savings from replacement of coal firing by gas firing for metallurgical heat treatment. The use of electricity is discussed critically. No advantages are offered with reference to the Newcastle area. WH (23)

Insulating Old Open Hearths to Improve Efficiency. S. M. Jenkins. *Steel,* Vol. 91, Nov. 14, 1932, pages 24, 26. Increased efficiency and reduced fuel costs are obtained in old open-hearth furnaces by partial rebuilding. The outside 9-in. red brick walls are replaced above the ground level with 2-ft. wide steel plates sealed to prevent air infiltration and completely insulated from the fire brick wall with high and low temperature insulating brick. JN (23)

Which Open Hearth Furnaces Are Needed for Russia? L. M. Fortunato. *Domez,* No. 12, 1932, pages 16-30. Theoretical discussion regarding advantages of stationary and tilting open hearth furnaces for present operating conditions in Russia. (23)

Close Control of Combustion Cuts Steel-Making Costs. *Iron Age,* Vol. 129, Feb. 18, 1932, pages 446-448. Describes the 100-ton Stevens basic open-hearth furnace used by Laclede Steel Co., Alton, Ill., and its economical operation. VSP (23)

Ford's 400-Ton Melting Furnace. Charles Longenecker. *Blast Furnace & Steel Plant,* Vol. 20, Nov. 1932, pages 833-834, 849; *Heat Treating & Forging,* Vol. 18, Dec. 1932, pages 710, 712. Describes tilting open-hearth furnace for melting discarded automobiles. Refining is carried out in other furnaces. Constant weight of metal is maintained in the furnace by tapping 50 tons at a time and charging a like weight. Overall length of melting chamber is 56 ft. 4 in. and width inside buck-stays is 22 ft. Extreme depth of bath is 4 ft. Width at surface of bath is 15 ft. Regenerators give waste gases and air 3 passes, 2 through checker-work and 1 through vertical flues which divide the regenerator into 2 sections. MS (23)

Dagenham and Pretoria Furnaces. W. S. Brown. *Blast Furnace & Steel Plant,* Vol. 20, Oct. 1932, pages 766-770; Nov. 1932, pages 835-837. Paper read before the Iron and Steel Institute. See "Blast-Furnace Engineering, with Particular Reference to the Dagenham Furnace of the Ford Motor Co., Ltd," *Metals & Alloys,* Vol. 3, Dec. 1932, page MA 359. MS (23)

Fuels in Heat Treating Furnaces. Influence of Intermittent Schedules on Costs. H. J. Gregg. *Metal Progress,* Vol. 23, Mar. 1933, pages 37-40. One result of the depression is the intermittent operation of heat treating furnaces. Fuel oil has replaced coal in some instances because of flexibility of control and lower labor cost, even though cost per B.t.u. is higher. Fuel oil is suitable for forges but not upsetters on account of scale. Electricity and gas are too costly for forging. Automatic control is difficult with fuel oil and handling is not as easy or clean as with gas or electricity. The advantages of heat economy, control, and even distribution made electricity desirable in prosperous times. With depression and high demand charges on low production, the cost has risen. Steady improvements in gas fired furnaces, "one" valve, automatic proportioning equipment, variable load, cleanliness, even temperature distribution, diffusion combustion and continuous gas carburizing have turned attention to gas. Fuel efficiency is lower than electricity, but lower cost per unit helps balance this item. Butane in tank cars is cheaper for some localities having high demand charges for gas. WLC (23)

Heat Treating Gears in Cyanide Pot and Drawing Oven. E. M. Kingsley. *Metal Progress,* Vol. 23, Jan. 1933, pages 13-18. A conveyor operated cyanide hardening pot and drawing oven combination in the Muncie Products Division of General Motors Corp. is described. The cyanide pot is 1 piece, heat resisting alloy which holds 4 tons of cyanide. The method of operation prevents scale and warping is so small that gears may be assembled for silent running immediately after inspection. The cost of operation per 12 hour day is 0.367c/lb., exclusive of burden. Both cyanide pot and drawing oven are gas heated and combine heat saving features with flexibility of operation. WLC (23)

Flexible Wire Conveyor Belts Aid to Continuous Heat Treating. *Steel,* Vol. 91, Nov. 14, 1932, pages 21-23. Various types of flexible wire conveyor belts used with continuous heat-treating furnaces are described. JN (23)

Heat Treating Furnaces in Forge Shops. R. R. La Pelle. *Heat Treating & Forging,* Vol. 18, Sept. 1932, pages 539-542. Illustrates and describes various types of electric and fuel-fired furnaces. MS (23)

REFRACTORIES & FURNACE MATERIALS (24)

Refractory Materials for Regenerators. Alfred B. Searle. *Blast Furnace & Steel Plant,* Vol. 20, Oct. 1932, page 796; Nov. 1932, pages 857-858. From *Metallurgia.* See "Refractory Materials for Air-Heating Furnaces," *Metals & Alloys,* Vol. 4, July 1933, page MA 233. MS (24)

Aluminum Oxide as High-Refractory Material (Aluminiumoxyd als Hochfeuerfester Werkstoff) H. Gerdien. *Zeitschrift für Elektrochemie,* Vol. 39, Jan. 1933, pages 13-20. See *Metals & Alloys,* Vol. 4, Oct. 1933, page MA 334. Ha (24)

Refractory Mortar for Patching Silica Coke-Ovens (Feuerfester Mörtel zum Flicken von Silika-Koksöfen) E. Comblés. *Stahl und Eisen,* Vol. 53, Sept. 21, 1933, pages 984-988. The main points for such a mortar are to grind fine and to add the right flux. Quartzite, quartz sand, and clay may be used. The mortar may be smeared or sprayed over the damaged parts while the coke-oven is in operation. Where rapid erosion occurred, or where the temperature was too low to sinter the mortar properly, cast-iron plates were employed with good results. SE (24)

Calculation from Physical Constants of Resistance to Change of Temperature of Refractory Bricks (Zur Berechnung der Temperaturwechselbeständigkeit feuerfester Steine aus ihren physikalischen Konstanten) K. Endell. *Glastechnische Berichte,* Vol. 11, May 1933, pages 178-182. Formula for determining the resistance against temperature changes or its reciprocal value, the temperature sensitivity, is developed using temperature conductivity, heat conductivity, specific heat and gravity, and tensile properties as factors. Formula developed previously by Norton is modified, and both equations checked against measurements. A table of various refractories and their physical constants is given. Ha (24)

Thermal Expansion of Refractories to 1800°C. R. A. Heindl. *Brick & Clay Record,* Vol. 83, Aug. 1933, pages 59-62. Seven chrome ores, 4 magnesites, 5 mullites, 2 fireclay bricks, 2 fire clays, 3 ball clays, 2 kaolins, 3 zircons and one each of spinel, silicon carbide, artificial carborundum, diaspore, bauxite, 80% alumina fire brick, silica brick, and insulating brick were included in the investigation. Pertinent data on analysis, linear thermal expansion, heat treatment, etc., are summarized in a table. Chips were taken before and after various heat treatments and petrographic analyses were made. Data for each specimen are given. CBJ (24)

Use of Standard Size Bricks in Furnace Construction (Die Verwendung genormter Steine im Ofenbau) E. Maase. *Stahl und Eisen,* Vol. 53, Nov. 9, 1933, pages 1156-1161. The standard bricks are 250x125 mm. or 230x115 mm. and 65 mm. thick; three-quarter brick; and bricks of the above dimensions but thinner. Construction designs of various furnace sections with the standard brick are illustrated. SE (24)

Elimination of Load Failures of Refractories. F. H. Norton. *Fuels & Furnaces,* Vol. 11, Nov.-Dec. 1933, pages 206-210, 214. Load-bearing properties of refractory materials and their relation to composition are discussed and numerical values as dependent on temperature given. Proper design can do much to reduce stresses and to provide cooling. Some construction details are described. Ha (24)

Electric Resistivity of Special Refractories (Elektrische Widerstandsfähigkeit feuerfester Spezialsteine) Philipp. *Technische Blätter der deutschen Bergwerkszeitung,* Vol. 23, Sept. 17, 1933, page 501. Refers to the importance which the knowledge of the electric resistance of refractories plays in electric furnaces. Reviews the comprehensive investigations by Werner: Ueber den elektrischen Widerstand einiger feuerfester Stoffe bei hohen Temperaturen. *Sprechsaal für Keramik, Glas, Email,* Vol. 63, 1930, and H. E. White: Electrical resistivity of Specialized Refractories. *Journal American Ceramic Society,* Vol. 15, 1932. GN (24)

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GASES IN METALS (25)

Effect of Oxygen on the Properties of Copper. (L'influence de l'oxygène sur les propriétés du cuivre.) W. Broniewski & S. Jaslan. *Comptes Rendus,* Vol. 196, Jan. 16, 1933, pages 174-177. Cu was deposited electrolytically and melted in a vacuum induction furnace. Oxygen was added in form of CuO. It was found that thermoelectric power and solution electromotive force are not much changed by oxidation. Electrical conductivity is slightly reduced. Hardness increases by 30% up to eutectic content of Cu_2O and then falls slowly. Elastic limit is somewhat changed. Properties most affected are tensile strength and percentage elongation. Presence of a solid solution of about 0.8% Cu_2O is indicated. OWE (25)

An Investigation of the Effects of Hydrogen and Oxygen on the Unsoundness of Copper-nickel Alloys. N. P. Allen & A. C. Street. *Institute of Metals, Advance Copy* No. 624, Mar. 1933, 21 pages. Alloys covering complete range of Cu-Ni were investigated. On melting in H all absorbed enough gas to make them very unsound on casting. They were melted in a controlled atmosphere and cast in same atmosphere. Alloys could be degasified by passing N over melt. Time required to degasify depended on composition. Degasified alloys made sound castings if they did not come in contact with O during cooling. Small amounts of O could be added to some of alloys containing minute amounts of H without producing unsoundness. Amount of O required to produce unsoundness was less than 0.001 for alloys containing less than 30% Ni, and of order of 0.02% for alloys richer in Ni. Unsoundness is probably due to reaction between H and dissolved oxides, producing steam, and porosity may take form of either small inter-dendritic holes, or a combination of small and large cavities. Microscopic examination indicated that complex oxides were present in alloys containing O. 12 references. JLG (25)

The Equilibrium of the Reaction Between Steam and Molten Copper. N. P. Allen & T. Hewitt. *Institute of Metals, Advance Copy* No. 623, Mar. 1933, 16 pages. Equilibria between Cu and H_2O in temperature range from 1090° to 1350° C. were studied. H_2O pressure was held constant by surrounding furnace with a gas-tight container, placing a trough of water in container near furnace, and immersing whole in a thermostat. A closed-end Pt tube inserted in furnace and connected to pressure gage made it possible to determine the H pressure at any instant. Experiments proved that the Pt was permeable to H and impermeable to other gases in container. Porosity of small ingots of Cu melted in contact with steam was dependent on H content rather than on O content. 11 references. JLG (25)

The Distribution of Porosity in Copper Ingots. N. P. Allen. *Institute of Metals, Advance Copy* No. 622, Mar. 1933, 21 pages. Porosity was determined by means of density measurements of small sections cut from the ingots and by macroscopic examination. In a tough-pitch Cu billet cast in an iron mold the portion adjacent to the surface had a low density. In most cases, however, for both tough-pitch and deoxidized Cu the density was greatest near the surface and low near the axis of the section. Tough-pitch arsenical Cu billets were cast and compressed by means of a piston as soon as there was no danger of molten Cu being squirted out. Average density of compressed billet was increased, but core had a low density. Low density of core was explained as being due to shrinkage on solidification and to wall of solid metal supporting ram. Pressures used ranged from 1.4 to 2.7 tons/in.^{2}. 4 references. JLG (25)

Studies in Gaseous Adsorption. III. The Thermal Activation Effect in the Adsorption of Hydrogen on Platinum and Nickel. E. B. Macted & Nissim Hassid. *Journal Chemical Society,* May 1932, pages 1532-1539. It was found that by thermal treatment surfaces normally not available for adsorption of gases can be made to adsorb them to a considerable extent. Results with Ni and Pt are described and an explanation of phenomenon attempted on basis of energy distribution among adsorbing elements. Ha (25)

Imprisoned Air and the Failure of Castings. J. G. Kennedy. *Engineer,* Vol. 154, Nov. 18. 1932, pages 520-521. Briefly sets forth theory as to cause of failure of castings under working conditions due to presence of imprisoned air. Air subjected to pressure compresses according to Boyle's Law and generates heat in conformity with the speed of the application of the load. When the load is applied to the imprisoned air slowly, heat is generated isothermally causing no apparent damage to the casting. When load is applied suddenly, the air is compressed adiabatically and the heat generated combining with the initial stresses already present produces stress sufficient to overcome the cohesion in the Fe and fracture results. LFM (25)

INSPECTION (26)

Measuring Machines (Messmaschinen). G. Berndt. *Archiv für technisches Messen,* Vol. 2, Nov. 1932, Section J 1126-1, page T 167. Devices for measuring automatically dimensions, pressures, and other mechanical quantities of articles in mass production. Ha (26)

Non-Destructive Methods of Testing Welds. G. A. Hankins. *Sheet Metal Industries,* Vol. 6, Aug. 1932, pages 239-241; Sept. 1932, page 307. Discusses testing methods by which welds may be observed by generating and measuring magnetic or electric fields in the neighborhood of the welds, by examining welds with X-rays, and by a hammering test coupled with use of a stethoscope to test purity of sound of welds. 28 references. AWM (26)

Automatic Inspection of Surfaces for Minute Defects. *Machinery,* London, Vol. 40, Sept. 8, 1932, page 710. Use of a photo-electric cell for surface examination and the machine which automatically rejects defective pieces briefly described. Kz (26)

X-Ray and Gamma-Ray Inspection as Used in Ship Construction. H. R. Isenburger. *Marine Engineering & Shipping Age,* Vol. 38, Apr. 1933, pages 137-139, 148. After discussion of X-rays and gamma-rays and their generation, the application in foundry and welding practice is dealt with. An X-rayed pilot casting shows possible defects which will be corrected by changes in foundry methods. Examples of defects are given. The application of X-ray examination for welded pressure vessels is outlined. Besides the importance of exographs for inspection, they are used for the development of the correct welding technique, since it is impossible to X-ray all welded seams in a ship hull. The St. John shock-proof and ray-proof X-ray unit is called suitable for hull inspections of plate joints and corroded areas. Kz (26)

EFFECTS OF ELEMENTS ON METALS & ALLOYS (27)

Influence of Manganese on the Hardenability of Carbon Steels. (Ueber den Einfluss von Mangan auf die Härtbarkeit der Kohlenstoffstähle.) W. Jellinghaus. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung,* Vol. 15, No. 2, 1933, pages 15-20. Influence of Mn on transformations of C steels is studied on a series of steels with C up to 0.89% and Mn up to 1.5% in its relation to cooling velocity. Pearlite temperature is appreciably lowered by addition of Mn and by increasing the cooling velocity. The velocity of formation of pearlite is reduced by Mn so that the formation of pearlite is already suppressed at fairly low cooling velocities. On the other hand, the formation of martensite takes place, as in unalloyed steels, at high velocities and is not suppressed, within the range investigated, even at high cooling velocities. The critical cooling velocities of C steels are lowered by addition of only 1% Mn by about 80%. The thermal analysis was confirmed by examination of the structures, photographs of which are reproduced. 8 references. Ha (27)

The Antimony Problem in Lead-rich Bearing Bronzes. (Zur Antimonfrage in bleireichen Lagerbronzen.) Edmund Richard Thews. *Die Werkzeugmaschine,* Vol. 36, Dec. 31, 1932, pages 452-453. The bronzes for the mentioned purpose are highly sensible to a great number of manufacturing conditions as melting temperature, casting temperatures—too high temperatures favor the detrimental formation of SnO_2—cooling velocity, and other external effects. However, though these conditions of proper manufacture may be fulfilled, failures may still occur, but in most cases they cannot be traced to the Sb content. Systematic tests and the literature on the subject prove the harmlessness or advantages respectively of small Sb contents (.2-.3%). Such contents are favorable due to the deoxidizing effect of Sb. Repeated failures of Pb-rich bronze bearing with the mentioned Sb content have other causes. GN (27)

Special Cast Irons. (Les Fontes Spéciales.) Léon Guillet & Marcel Ballay. *Bulletin de l'Association Technique de Fonderie,* Vol. 16, Sept. 1932, pages 582-597. Paper at World Foundry Congress, Paris, 1932. Review of previous work with comments. Includes special cast irons containing Si, Cr, Ni, Monel metal, Mn, Cu and Al. 16 references. WHS (27)

The Influence of Carbon on 10% Manganese Alloys. John Eckel & V. N. Krivobok. *Mining & Metallurgical Investigations, Carnegie Institute of Technology, Mining & Metallurgical Advisory Boards,* 6th Open Meeting, Oct. 28, 1932, 2 pages. The paper deals with pure alloys of Fe with 10% Mn and from 0.01 to 1.4% C. The phase diagram at substantial equilibrium was determined. Ha (27)

The Influence of Phosphorus on the Properties of Hardened and Tempered Cast Iron. J. E. Hurst. *Iron & Steel Institute, Advance Copy* No. 6, May 1933, 23 pages. A series of irons containing 3.5% total C, 0.5% comb. C, 1% Mn, 0.6% Cr, and from 0.035 to 1.56% P were used. Specimens were taken from centrifugally-cast drums. Some were tested as cast and some after various heat treatments. The experimentally determined values are given. In the as-cast condition increasing P increased Brinell hardness and modulus of elasticity, while tensile strength, area under the stress-strain curve, and permanent set decreased. After quenching in oil from 875° C. all irons had a Brinell hardness of over 500. The greatest increase in hardness was in the high-P irons. Quenched specimens were tempered at several temperatures. Tempering at 600° C. reduced hardness of all irons to the original value. Stabilizing, which consisted in heating to 550° C., did not greatly affect hardness. The softening resulting from annealing at 900° C. increased as the P increased. JLG (27)

Influence of Small Admixtures on Mechanical and Corrosion Resisting Properties of Zinc. (Einfluss geringer Beimengungen auf das mechanische und korrosionschemische Verhalten von Zink.) A. Burkhardt & G. Sachs. *Metallwirtschaft,* Vol. 12, June 9, 1933, pages 325-328; June 16, pages 339-342. Electrolytic Zn, 99.97% pure, was used, and additions consisted of .001 to as high as 1% of Ag, Al, As, Bi, Ca, Cd, Cu, Fe, Hg, Li, Mg, Ni, Pb, Sb, Sn, and Tl. Pure Zn can be rolled at any temperature, but most alloys are limited, usually to between 100° and 160° C. Zn with Pb and Cd additions is the easiest to roll, while it is impossible to roll Zn with more than .003% Sn. Bi, Hg, Sb, and Th have a harmful effect on the tensile strength and elongation of rolled Zn, As and Ca have no effect, and all others increase the strength. Mg, Li and Cd are especially beneficial. The temperature, at which the strength of Zn is lowered due to heating, is raised by almost all alloy additions, especially by Cd. The bending properties in the rolled and annealed condition are not much affected by Mg, Bi, Tl, and Cd. In the annealed condition they are improved by Sb and Al additions, all others improve them in both annealed and rolled conditions. .01% Ni raises the bend test number of annealed pure Zn from 5 to 30. The endurance limit of Zn is affected by the various additions in the same manner as the tensile strength. The corrosion resistance was determined by immersing test sheets in 18% by weight H_2SO_4 solution and measuring the temperature increase of the solution after 15 min. Additions of Fe, Ni, and Sb are very harmful, As, Bi, Al, Ag, and Cu are also harmful. Tl and Ca have no influence, while less than .01% Mg and certain amounts of Cd, Hg, Pb, and Li increase the corrosion resistance. It is not possible to counteract the harmful effect of Fe by the addition of any of the beneficial metals. 8 references. CEM (27)

The Influence of Several Less Common Elements When Added to Cast Iron. J. E. Hurst. *Foundry Trade Journal,* Vol. 48, Feb. 23, 1933, pages 137-139. Effects (so far as they are known) of the following elements are summarized: Be, B, Na, K, Mg, Ca, Zn, Se, As, Zr, Sn, Sb, Ce, Pb and Bi. OWE (27)

Alloy Steel Castings. W. F. Rowden. *Metallurgia,* Vol. 7, Apr. 1933, pages 191-193. Briefly discusses production of steel for casting in acid open-hearth, and influence of alloying elements on steel. Particular attention is paid to Mo. JLG (27)

Alloyed Malleable Cast Iron. (Legierter Temperguss.) E. Söhnchen. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 54, Apr. 16, 1933, pages 151-153. Alloys may be added to common malleable cast Fe for following reasons: (1) deoxidation and degassification, (2) accelerated formation of graphite, (3) fining of the graphite. Among few elements suitable for this purpose Ti and V are to be mentioned. Piwowarsky states that Ti favors a fine graphite finely distributed in the matrix, accelerated disintegration of carbides and a rapid C gasification during malleableizing. Instead of use of Ti, Schwartz suggests Al. The favorable effect of Al was substantiated by investigations of J. H. Hruska (*Foundry,* 1931, page 70). However use of Al is limited on account of difficulties in casting with higher Al contents. Experiments to improve malleable cast Fe by Ni are discussed, showing that improvement attainable depends on correct selection of the other alloying constituents. Ni is best suited for this purpose. Low Cr content favors favorable action of Ni. Experiments on Cu-alloyed malleable are briefly cited. The wear resistance of alloyed malleable is referred to. GN (27)

Influence of the Carbon Content on the Structure and Tensile Properties of Gray Cast Iron, with Consideration of Different Silicon Contents, Casting Temperatures and Wall Thicknesses. (Einfluss des Kohlenstoffgehaltes auf das Gefüge und die Festigkeitseigenschaften des grauen Gusseisens, unter Berücksichtigung verschiedener Siliziumgehalte, Giesstemperaturen und Wandstärken.) A. Koch & E. Piwowarsky. *Die Giesserei,* Vol. 20, Jan. 6, 1933, pages 1-7; Jan. 20, 1933, pages 26-31. In order to evaluate properly influence of C and Si, wall thickness and casting temperature on graphite content, structure, bending strength, tensile strength, hardness and endurance impact strength, a series of systematically built-up cast iron melts was made and tested. Results can be summarized briefly as follows: Graphite content increases with C content; the weakening of structure on account of increasing amount of graphite deteriorates all tensile properties. As liquidus line rises with decreasing C "effective" overheating is reduced, for same casting temperature, with decreasing C; a finer structure results and endurance impact strength is particularly improved. Si increases castability of cast iron but also deteriorates mechanical properties as graphite precipitation is favored. By increasing cooling velocity influence of Si can to a certain extent be counterbalanced; each C content has, therefore, an optimum of Si content. Graphite content increases with increasing wall thickness and bending and tensile strength are deteriorated in about same ratio. With decreasing C content the wall thickness sensitivity decreases. While bending and tensile strength depend directly on the graphite content and, therefore, on the wall-thickness, the finer structure and graphite lamellae at small wall-thicknesses effect an extraordinary increase of the endurance values, especially in low C irons. Increasing casting temperature increases the preheating of the mold which results in a retardation of the cooling process and favors the graphite precipitation and reduces correspondingly the mechanical properties. As low as possible a casting temperature is therefore required for obtaining high mechanical values, lower limit being given by the liquidus point corresponding to the composition of the iron so that the mold is filled in all its parts. The test results are given in curves and tables. 27 references. Ha (27)

EFFECT OF TEMPERATURE ON METALS & ALLOYS (29)

The Pomp-Enders Short-Time Creep Test. *Engineering,* Vol. 134, Aug. 26, 1932, pages 232-234. Abstract translation of article by Pomp & Höger entitled "Dauerstandfestigkeitsuntersuchungen an Kohlenstoff- und niedriglegierten Stählen nach dem Abkürzungsverfahren" in *Mitteilungen aus dem Kaiser-Wilhelm Institut für Eisenforschung,* Vol. 14, No. 4, 1932, pages 37-57. See *Metals & Alloys,* Vol. 4, May, 1933, page MA 160. LFM (29)

Carbon Steel Tubes at 400°C. Steam Temperature. (Kohlenstoffstahlrohre bei 400°C. Dampftemperatur.) *Archiv für Wärmewirtschaft und Dampfkesselwesen,* Vol. 14, Feb. 1933, page 52. The results of tensile and notch impact tests on C steel and 3% Ni-steel tubes for steam lines of the Klingenberg power plant, Berlin, are briefly summarized. GN (29)

With ever increasing temperatures and pressures==what?

These abstracts are prepared in cooperation with the Joint High Temperature Committee of the A. S. M. E. and the A. S. T. M.

Electrical Conductivity of Metals at the Lowest Temperatures. *Engineer,* Vol. 153, June 10, 1932, page 635; Vol. 154, Aug. 25, 1932, page 208; *Engineering,* Vol. 133, June 24, 1932, page 734; *Nature,* Vol. 129, June 11, 1932, pages 858-859. Summary of address delivered by J. C. McLennan at the Royal Institution of Great Britain, London, June 3, 1932. Copper sulphide, SnAs, PbS, and the carbides of Ta and Nb were found to be super-conductive at low temperatures. Ag_3Sn was not super-conductive but a eutectic of this compound and tin was found to be super-conductive. Other eutectics were found to be more super-conductive than compounds and than metals. The stretching of wires while in the super-conductive state was found to raise the transition temperature. Kz + LFM (29)

The High-temperature Hardness-test of Iron and Steel. MATSUJIRO HAMASUMI. *Journal Society of Mechanical Engineers,* Tokyo, Vol. 35, Aug. 1932, pages 761-765. Paper read before 2nd General Meeting, Society of Mechanical Engineers, April 6, 1932. Described is a new hardness tester with which different kinds of iron and steel were tested in a vacuum at temperatures up to 900° C. Results are summarized in tables and graphically presented. Kz (29)

Scaling of Steel at Heat Treating Temperatures. *Heat Treating & Forging,* Vol. 18, Dec. 1932, pages 708-709. From the report of the Committee on Industrial Gas Research of the American Gas Association. Reviews work done at University of Michigan. See *Metals & Alloys,* Vol. 3, June 1932, page MA 189. MS (29)

Hard Surfacing Valves for Steam Service at High Temperatures. *Power,* Vol. 77, Mar. 1933, page 115. A large mid-western power company has effected considerable economies in valve operation by applying Stellite to gates, rings, disks, seats, etc., by the oxy-acetylene process. AHE (29)

Engineering Research at the National Physical Laboratory. H. J. GOUGH. *Transactions Institution of Engineers and Shipbuilders in Scotland,* Vol. 76, Feb. 1933, pages 205-258. Includes discussion. A general review is given of origin, growth, and work of National Physical Laboratory, with special reference to engineering department. Accounts of 2 major investigations follow: *Study of the mechanical properties of materials at high temperatures* involves (1) Measurement of creep properties of common materials. 24 machines are installed. The limiting creep stress, when failure is not caused by intercrystalline cracking, is taken as the stress which, after 40 days, produces creep of 10^{-5} inches per inch per day. (2) Development of new alloys. The alloy 30% Ni, 28.5% Cr, 3.8% W, 1.05% Si, 1.34% C, withstands 3 tons/in.^{2} at 800° C. for 49 days without failure. (3) Investigation of laws of creep. (4) Systematic study of alloy steels. At 550° C. Mo improves creep resistance, but influence of previous history and heat treatment complicates comparisons. Fatigue, torsion, and impact tests at high temperature have also been devised. *Investigation of failures of chains and lifting gear* established that brittle fractures are due to the formation of a brittle surface layer by repeated small impacts during use or through cleaning by rumbling. Annealing at 750° C. is a cure. Below 15° C., also, notched bar brittleness becomes apparent and discontinuities may thus be a serious cause of weakness in cold weather. JCC (29)

Creep of Metals Measured in Millionths of an Inch. *Power,* Vol. 27, Mar. 1933, page 131. The creep test is the best known means of predicting the value of a material for high temperature service involving small permissible deformations. Its limitations are discussed. AHE (29)

The Creep of Materials and Creep Stresses—VI. JAS. CUNNINGHAM. *Steam Engineer,* Vol. 2, Dec. 1932, pages 135-136. A continuation of a general article. AHE (29)

Creep and Structural Stability in Nickel-Chromium-Iron Alloys at 1600°F. W. A. TUCKER & S. E. SINCLAIR. *Bureau of Standards Journal of Research,* Vol. 10, June 1933, pages 851-862. Study was made of creep characteristics at 1600° F. of 15 alloys covering a range from 1-75% Ni and from 3-55% Cr. The results were compared with those of a previous investigation at 1000° F. on similar alloys. In the investigation at 1000° F. of the Ni-Cr-Fe system it was found that the alloys containing little or no Fe, 50-80% Ni and 20-50% Cr exhibited the greatest resistance to creep. At 1600° F. the strongest alloys are those containing approximately equal parts of Ni and Cr and not more than 30-40% Fe. As part of a metallographic study the attempt was made to distinguish between the effect on structure of elevated temperature alone and of elevated temperature and stress combined. A comparison was made between the structure in specimens used in creep tests and that in unstressed specimens of the same alloys annealed at 1600° F. for periods ranging from 100-1000 hours or quenched in iced brine from that temperature. In nearly all cases the quenched specimens were similar in structure to the annealed materials which indicates that these alloys were not readily heat treated. Carbide precipitation and agglomeration of the carbide at the grain boundaries were most pronounced in both the binary Fe-Cr and the ternary Ni-Cr-Fe alloys of higher Cr content. Prolonged heating of both stressed and unstressed specimens did not produce any pronounced changes in the structure of the binary Fe-Cr or the ternary Ni-Cr-Fe alloys except those containing 50% or more of Ni. WAT (29)

Copper-Beryllium Wires at Low Temperatures (Beryllium-Kupferdrähte bei tiefen Temperaturen) R. WALLE. *Zeitschrift für Metallkunde,* Vol. 25, May 1933, page 123. Brief note on the tensile properties: tensile strength, elongation, and reduction of area, of a Cu-Be alloy with 2.5% Be in the unaged and in the aged (160 min. at 260° C.) at the temperatures + 20° and — 70°. In both the unaged and the aged conditions these properties all increase on lowering temperature. RFM (29)

Creep Phenomena, a New Technically Important Problem of the Elasticity Theory (Die Kriecherscheinungen, ein neuer technisch wichtiger Aufgabenkreis der Elastizitätstheorie) A. STODOLA. *Zeitschrift für angewandte Mathematik und Mechanik,* Vol. 13, Apr. 1933, pages 143-146. Mathematical treatment of the creep deformation of a rod submitted to bending stress as an example for the single-axial stress state. The literature statements on creep under bi-axial stresses are summarized. The cold creep of Pb appears to be closely related to the creep of metals at elevated temperatures. Stodola derives a formula on the creep velocity of steel:

$$w = a\left(\frac{t - t_0}{100}\right)^m \left(\frac{\sigma}{100}\right)^n ,$$

wherein t = °C., σ = stress in kg/cm.^{2}, a = 12.5 × 10^{-9}, m = 6.63, n = 3.16, t_0 = 600. The formula is valid between 700° and 1000° C. and at tensional stresses ranging from 0-500 kg./cm.^{2}. WH (29)

The Strength of Steel, Cast Steel, and Cast Iron at Low Temperatures (Festigkeitseigenschaften von Stahl, Stahlguss und Gusseisen in der Kälte) RICHARD WALLE. *Die Chemische Fabrik,* Vol. 6, May 17, 1933, pages 207-211; May 24, pages 220-222. Review of 15 references to literature on tensile properties, including stress-strain curves, bend tests, and hardness tests of carbon and alloy steels, cast steel, and cast iron at temperatures as low as -200° C. CEM (29)

Methods of Determining Creep Properties. H. J. TAPSELL. *Mechanical World & Engineering Record,* Vol. 93, Mar. 17, 1933, pages 264-265. The study of the long-time creep properties of a steel at high temperatures may follow either or both of 2 courses: (1) An investigation of the general creep characteristics. (2) The determination of creep deformation under defined conditions of stress and temperature. A criterion of creep-resistance is the limiting creep stress —i.e., the stress which corresponds with a creep rate of 10^{-5} in./in./day at 40 days. Kz (29)

Creep of Steels. H. J. TAPSELL. *Mechanical World & Engineering Record,* Vol. 93, Mar. 10, 1933, pages 236-237. Creep of steels requires careful consideration in the design and operation of high temperature and high pressure plants. Some measure of deformation by creep is permissible and assuming this to be 1% per year, the average creep rate must not exceed 2.74 × 10^{-5} in./in./day, or 1.14 × 10^{-6} in./in./hour. Creep curves of a number of steels tested under various conditions of stress and temperature are presented, and show a first stage of decreasing creep rate followed by a stage of increasing creep rate leading to fracture. The initial creep strain and the rate of decrease of creep strain in the first stage are greater at lower temperatures (300°-467° C.). In tests at 800°-900° C. the first stage is absent. The variation of creep rate with stress is discussed with diagrams which also permit a comparison of the creep-resisting properties of the steels investigated. Kz (29)

Creep Properties of Metals. H. J. TAPSELL. *Structural Engineer,* Vol. 10, Jan. 1932, pages 15-25; Discussion, Mar. 1932, pages 146-149. A paper read before the Institute of Structural Engineers, Jan. 1932. Creep curves of various ferrous and non-ferrous materials at different temperatures are presented. A study of the deformation of materials subjected to prolonged loads until fracture occurred shows that they normally consist of 4 main stages: (1) a practically instantaneous strain made up of elastic (recoverable) strain together with an inelastic (non-recoverable) strain; (2) strain which proceeds at a decreasing rate with time as a result of hardening; (3) a minimum rate of strain which occurs at a point of inflection in the deformation time curve; (4) an increasing rate of strain leading to fracture. Log rate of creep curves at 300°-600° C. are shown for heat treated NiCr steel and creep properties of some 11 different ferrous and non-ferrous alloys are compared with short time tensile properties and a comparison between low alloy steels and plain C steels is made. Although many experimental data are presented, the speaker theoretically deals with the nature of the phenomenon of creep. In conclusion some desirable research work in this field is pointed out. WH (29)

Short-time Creep Tests. H. J. TAPSELL. *Mechanical World & Engineering Record,* Vol. 93, Mar. 31, 1933, pages 312-314. Critical discussion of short-time creep tests proposed by Pomp and Enders, who defined their creep limit as the stress corresponding with a creep rate of 0.003% per hour, or 0.00003 in./in/hour; Siebel and Ulrich, who defined their creep limit as the stress which produces a rate of creep of 10^{-6} in./in./hour when the creep deformation has reached 0.2%; and Hatfield defines a creep limit, the "time-yield," as the stress which produces not more than 0.5% deformation in 24 hours, and an average creep rate of 10^{-6} in./in./hour in the next 48 hours. Short time creep tests are of value chiefly as specification tests of materials whose general creep characteristics have already been examined. Subjects such as intercrystalline cracking, strain-hardening and recrystallization are touched upon. Creep properties of a number of steels are given and discussed. Kz (29)

Characteristics of Steel at Elevated Temperatures. FRANCIS B. FOLEY. *Refiner & Natural Gasoline Manufacturer,* Vol. 12, May 1933, pages 180-183. Plain C steels are useful up to about 850° F., low alloy pearlitic steels up to 1100° F., and high alloy steels at the higher temperatures. The tedious creep test is the only means of selecting accurate data for elevated temperature service. Creep testing apparatus of the Midvale Co. is described and illustrated in detail. Short time test data in charts are presented for .28% C; .21% C, 4.5% Cr, 0.6% Mo; 0.05% C, 18-8 alloy; 0.44% C, 14.5% Cr, 28% Ni, 3.4% W; and 4 alloys containing from 17-25% Cr and 10-60% Ni to temperatures up to 1700° F., in some cases, and to 2000° F. for the latter 4 alloys. Grain boundary carbide precipitation may be overcome in high Cr alloys by adding more Cr to the alloy, as the carbide in forming draws the Cr from the metal adjacent to the C. Increasing Ni also decreases precipitation, and elements as Mo, Ti, and W to a lesser degree. In alloys of the 25 Cr-20 Ni type the elements are sufficient to prevent any corrosive attack at all. Such high alloy additions however decrease room temperature ductility, particularly in alloys that have been exposed for long periods at elevated temperatures. This same effect is present in low alloy steels containing Ni in excess of 2% and absent when over 0.6% Mo is added. Reduced ductility is also found in certain higher temperature ranges depending on composition and metallographic condition. WAT (29)

Nickel and Nickel Alloys for Oil Refinery Equipment. O. B. J. FRASER. *Refiner & Natural Gasoline Manufacturer,* Vol. 12, May 1933, pages 162-173. The use of Monel metal for valve parts in the refinery equipment is discussed. The short time mechanical properties of 80-20 Cu-Ni and 70-30 Cu-Ni alloys together with Ambrac and Admiralty metal are given to 1100° F. The pearlitic steels containing from 2-5% Ni are very tough at low temperatures (—100° F.). Use of low Ni alloy steels in the refinery industry is discussed in a very general way. Likewise high Ni alloy steels. Properties of ordinary cast Fe are increased by the use of low percentages of Ni. Properties of Ni-resist cast Fe, high Ni high alloy content cast Fe, are given for resistance to oxidation and growth at 1500° F., and are compared with the properties of ordinary cast Fe. Corrosion resistance of Ni-resist cast Fe is outlined and compared with ordinary cast Fe. Ratio of relative corrosion rate of these two types of irons are compared in a table compiled from practical tests in which 62 different chemical reagents and corrosive solutions are listed. Chart presented showing rate of penetration of H_2SO_4 from 0-95% concentration of bronze, Monel and Causul metal, and Pb at 70° F. Causul metal is a special type of Ni-resist cast Fe, and is fairly comparable in resistance to acid with Pb. Bronze and Monel metal are attacked at a relatively greater speed. WAT (29)

REDUCTION METALLURGY (31)

Charging of Ore and Fluxes According to Physical Principles. (Möllerung nach physikalischen Grundsätzen.) A. Wagner, A. Holschuh & W. Barth. *Stahl und Eisen,* Vol. 52, Nov. 17, 1932, pages 1109-1118. Investigations on permeability to gases of stratified material in blast furnaces have indicated that operation and output can be improved by charging furnace so that horizontal sections are uniform; this tends to more rapid reduction with lowered coke consumption. If raw materials are suitably prepared in crushing, screening and sintering plants to produce uniform size of pieces in different materials, increased economy in operating a blast furnace will justify additional investment of capital in these preparation plants. Pieces smaller than 10 mm. should not be used. This method of charging creates equal resistance to flow over the whole section and gives great uniformity of distribution of CO and CO_2. Experiments in a few blast furnace plants are described in detail; coke consumption was about 10% less on the average than for usual mixed charge of fluxes and ore. Furnace gases were well utilized and charge descended uniformly. Wind pressure can be reduced. Ha (31)

Production of Chromium-Nickel Steels from Khalilov Irons. N. N. Inshakov. *Domez,* No. 12, 1932, pages 1-15 (In Russian). Khalilov Fe ore deposit contains about 100 million tons of 40% Fe containing sufficient Ni and Cr to produce pig Fe with about 3% Cr, 0.75% Ni and 0.3-0.4% P. From this Fe was produced, in open hearths, entirely satisfactory steels containing all Ni originally present in the Fe, but only about 0.5% Cr. High Cr content in slag complicates and lengthens furnace practice, particularly when slag has to be run off on account of high P. (31)

Roasting of Sulphides, Especially That of Nickel (Sur le grillage des sulfures: des mattes de nickel en particulier) B. Bogitch. *Comptes Rendus,* Vol. 196, Mar. 13, 1933, pages 782-784. Results are given of roasting commercial Ni sulphide for various lengths of time at various temperatures. The residual S at first increases, attains a maximum corresponding roughly to Ni_3S_2, and then decreases. It is these variations in residual S which complicate process. Residual S can be accounted for from partial pressure of SO_2. Commercial practice is explained in accordance with these results. OWE (31)

If You Smelt Ores
Here Are New
Ideas for You.

Slag Calculation and Charge for Smelting of White Metal Dross (Schlackenberechnung und- möllerung für die Verhüttung zinnhaltiger Weissmetallrückstände) E. R. Thews. *Die Metallbörse,* Vol. 22, Dec. 24, 1932, pages 1645-1646. The difficulties of melting down the comparatively small quantities of white metal scrap of greatly varying composition are pointed out. Soda should be restricted to 0.5-1% besides low amounts of CaF_2 and Fe-oxide. The slag must be of a reasonably low m.p. $CaCO_3$ is 10-15% of the Fe-oxide present. A universally applicable slag composition does not exist. Thews advises to employ tentatively the following mixture: 45% FeO, 25% SiO_2, 10% $CaCO_3$ and 10% CaF_2. About 3-5% are added to the dross and the whole is heated up to melting temperature. If no slag forms, further additions of CaF_2 or soda are made in low amounts. Instead of Fe-oxide, Sn-plate scrap (2-3%) often is used. EF (31)

Stannous Oxide and the System SnO-SiO_2 (Über Zinnoxydul und das System SnO-SiO_2) B. Keysselitz & E. J. Kohlmeyer. *Metall und Erz,* Vol. 30, May 1933, pages 185-190. Tests made in a small crucible in a vertical electric laboratory furnace showed that SnO goes through an irreversible modification at 490° C. with the formation of heat and change in color from brown to gray. In N atmosphere, SnO decomposes at 540°. At 725° it reaches a constant value: $7SnO = 5SnO + SnO_2 + Sn$. This condition does not change up to the melting point, about 1000°. When mixed with SiO_2, SnO dissolves in it slightly below 540°, which prevents decomposition. Up to 47% SiO_2, these silicates begin to melt at 890°. The composition 1 SnO:1 SiO_2 has lowest melting point, 890°. SnO_2 is not soluble in Sn silicates up to 1250°. No noticeable volatilization of SnO occurs up to 1000°, and in solution in SiO_2 none up to 1250°. SnO begins to reduce in H at 410° and in CO at 540°. CEM (31)

Treatment of Concentrates at Nikitovsky Quicksilver Combine. V. A. Vanyukov. *Tzvetnuie Metallui,* No. 2, Feb. 1932, pages 136-146. Describes laboratory and plant experiments for extraction of Hg from rich table and flotation concentrates (22 to 44% Hg) in a reverberatory furnace. Recovery is as high as 99%. BND (31)

Reducibility of Beryllium Oxide (Ueber die Reduzierbarkeit des Berylliumoxydes) W. Kroll. *Wissenschaftliche Veröffentlichungen aus dem Siemenskonzern,* Vol. 11, July 8, 1932, pages 88-92. The reducibility of BeO with C, Si, Al, Li, Mg, Ca and Ce was studied. In reducing BeO with C a highly carburized Be-containing metal is obtained in the presence of Ni or Fe; the C could not be removed by any treatment. In the presence of Cu a sintered product containing Be-Cu alloys and having a melting point higher than the boiling point of Cu is obtained. The reduction of BeO in presence of Fe with Ca, Mg, Al, Si, Li and Ce in high-frequency furnace produces alloys of Be with Fe only by use of Ca or Ca-containing mixtures. An equilibrium is formed between Be of Fe- and Ca-containing slag which has a great tendency to form BeO so that Be content in alloy is very small. No practical method could be developed. 6 references. Ha (31)

Commercial Production of Rhenium and Gallium (Die technische Gewinnung von Rhenium und Gallium) F. Weit. *Die Metallbörse,* Vol. 22, June 1, 1932, pages 690-691. Mansfield ores carry both Ga and Re (2×10^{-7}%) which are more concentrated in certain intermediary products in company with other heavy metals, preferably Mo. The Vereinigte Chemische Fabrik, Leopoldshall, works up these intermediary products and produces 150 kg. of Re annually. Chemistry of Re with reference to extraction process is reviewed. Commercial utilization as catalyst and in thermo-couples has just started. The separation from heavy metals as well as from Mo and V and various chemical operations of production process are given. Finally electro-deposited metal is extremely pure. Commercial use of Ga for thermometers (above 1000° C.) and non-poisonous dental fillings, instead of amalgams, are mentioned. Present price for 1 kg. Re = 14000 R.M. and Ga = 10000 R.M. EF (31)

Electrothermic Preparation of Cuprosilicon. V. Verigin. *Tzvetnuie Metallui,* No. 3, Mar. 1932, pages 369-374 (In Russian). Describes the preparation of cupro-Si in an electric furnace to give a product containing 58% Si, 40% Cu and about 1% Fe, and possessing good physical and chemical properties. BND (31)

Reactions in the Solid State (Reaktionen in fester Phase) H. Trapp. *Die Metallbörse,* Vol. 22, Dec. 31, 1932, pages 1629-1630; Vol. 23, Jan. 4, 1933, pages 1-2; Jan. 11, 1933, pages 34-36. Mainly refers to investigations of Hedvall, Jander, Tammann, Nernst, Baukloh, Grube, Marshall, Fischbeck & Jellinghaus. The changes in the solid state are as follows: (1) gas + crystal I = crystal II (oxidation of metals); (2) liquid + crystal I = crystal II (deposition of incongruently melting compounds); (3) crystal I + crystal II = crystal III (a) dissolving of pearlite (b) reactions such as $2 Ag + S = Ag_2S$; (4) crystal I + crystal II = crystal III + crystal IV (alumo-thermal reactions and $CaCO_3 + BaO = BaCO_3 + CaO$); (5) more complicated compounds originated alongside several phases. Metallurgical reduction of oxides by solid C, formation of slags and glasses, and diffusion of metals are treated. EF (31)

Mechanization of the Raw Material Handling in a Blast Furnace Plant. T. G. Oreshkin & N. K. Trofimov. *Domez,* No. 11, 1932, pages 34-52 (In Russian). Advantages of replacing hand labor with mechanical handling are discussed. (31)

Apparatus for Automatic Registration of the Level of Blast Furnace Charge. I. B. Boutowetzky. *Domez,* No. 8, 1932, pages 69-73. (In Russian). Mechanical details of apparatus (Russian Patent 18191) for recording and indicating the level of blast furnace charge. (31)

Turbo-Blowers for Blast-Furnace Plants. J. T. Moore. *Metallurgia,* Vol. 8, Aug. 1933, pages 99-103. Discusses advantages and characteristics of turbo-blowers. JLG (31)

Methods for Calculation of Typical Blast Furnace Burdens. A. D. Gotlieb & N. V. Rulla. *Domez,* No. 10, 1932, pages 1-12; No. 11, 1932, pages 24-33 (In Russian). Detailed calculations of burdens which might be used when coke of specific characteristics is obtainable and when some of the present day low-grade ores will be available as enriched aggregates. (31)

Electrical Blast Furnace Plant. C. H. S. Tupholme. *Electrical Review,* Vol. 111, Sept. 30, 1932, page 461. Describes control gear for the automatic control of furnace skip hoist, revolving top, and scale car. MS (31)

The Influence of Furnace Size on Fuel Consumption in Pig Iron Production. Edgar C. Evans. *Journal West of Scotland Iron & Steel Institute,* Vol. 40, Session 1932-3, Dec. 1932, pages 35-47. Effect of hot blast furnace design, etc. based on historical evidence. 13 references. GTM (31)

Comparative Smelting Power of Coal and Coke. Roy P. Hudson. *Iron Age,* Vol. 30, Nov. 3, 1932, page 685, adv. page 18. Blast furnace generally requires greater amount of coal than coke to produce a ton of Fe due to lack of porosity of coal. Difference in rate of driving between coal furnace and coke furnace is due to volatile matter of coal. Rate of combustion of coke is 2-2½ times that of anthracite. Ton of pig Fe can be produced with fuel consumption of 2700 lbs. of coal or 1600 lbs of charcoal. Porosity and combustibility have been overstressed, while chemical composition of fuels has not been given sufficient attention. VSP (31)

Composition and Deoxidation of Iron Oxide Sinters. T. L. Joseph, E. P. Barrett & C. E. Wood. *Blast Furnace & Steel Plant,* Vol. 21, Mar. 1933, pages 147-150; Apr. 1933, pages 207-210; May 1933, pages 260-263; June 1933, pages 321-323, 336. Includes bibliography. Paper read before Eastern States Blast Furnace and Coke Oven Association. The composition, strength, bulk density, and porosity of 13 commercial sinters varied widely. Porous sinters were, in general, weaker than dense sinters. It is possible to obtain comparatively strong sinters that also have average or more than average porosity. Direct measurements of rates of deoxidation were made. Time required to remove 95% of the O_2 from —0.742 + 0.525-in. pieces of sinter, subjected to a stream of H_2 at 950° C. varied from 1.25 hrs. for porous sinters to more than 7.5 hrs. for dense sinters. This variation is attributed largely to differences in gas permeability, which does not change quantitatively with changes in porosity. This wide variation disappeared when —100-mesh particles were deoxidized with H_2 at 950° C. Chemical composition of sinter has an indirect effect upon reducibility through its influence on the physical structure resulting from sintering. Large variations in reducibility were observed when fine particles were reduced with H_2 at 600° C. It seems that part of Fe is present in compounds that are not readily reduced at 600° C. At 950° C. all of Fe-bearing compounds are reduced readily when a large surface is exposed to H_2 and H_2O is removed readily. As gangue increases, more Fe will be present in compounds that are not reduced readily at 600° C. Tests on 6 Fe ores indicate that ores are more reactive than sinters toward H_2 at 950° C. Since maximum continuous sections in pieces of sinter do not correspond with over-all dimensions, it can not be concluded that larger pieces of ore will reduce more readily than comparable sizes of sinter. There is no justification for a generalization as to relative reducibility of ores as compared to sinters. MS (31)

Reduction Studies with Iron Ore and Sinter During Actual Operation of a Blast Furnace (Reduktionsversuche mit Eisenerzen und Sinter unmittelbar am Hochofen) W. Feldmann, J. Stoecker & W. Eilender. *Stahl und Eisen,* Vol. 53, Mar. 23, 1933, pages 289-300. By means of sampling tubes placed in different zones of a blast furnace, the rate of reduction, gas composition and pressure, temperature, and condition of mix, for different ores and sizes of ore were studied during operation. Rate of reduction increased rapidly with rate of gas flow. For a certain temperature of working there is an optimum gas flow beyond which the coke consumption per ton increases. The most finely divided ore was reduced most rapidly. Through the formation of a glassy sintered surface the mix becomes harder to reduce but this can be overcome largely by proper charging. Samples taken from the bosh indicated the progress of reduction with different kinds of Fe ore and provided a valuable means of judging their quality. SE (31)

Blast Furnace Smelting Practice. A. John MacDonald. *Blast Furnace & Steel Plant,* Vol. 20, Dec. 1932, pages 883-886; Vol. 21, Feb. 1933, pages 103-106; Mar. 1933, pages 157-158; Apr. 1933, pages 215-222; May 1933, pages 258-259, 265-266. Discusses effect of SiO_2, Al_2O_3, CaO, MgO, MnO_2, and $Ca_3P_2O_8$ in Fe ores on blast-furnace operation. There should he sufficient SiO_2 in raw materials to provide a slag of proper composition, volume, and desulphurizing power and some Si in the pig-Fe. All above this required amount is a burden on process, lowers the standard of good practice, raises costs per ton by increased fuel and flux, and decreases tonnage. High Al_2O_3 slags are beneficial in making high-Si Fe with a high hearth temperature and promote desulphurization as long as they are kept hot. They require more fuel and are detrimental in manufacture of low-Si and low-C Fe. CaO and MgO content of ores commercially worked at present are a benefit to operation. High MnO_2 in ores is desirable for the manufacture of Fe for the basic open-hearth process and about 5% of an ore containing 5-10% Mn usually is charged in the blast furnace. Varying amounts of Mn are useful in foundry Fe and low Mn for acid steel process. Mn in not excessive amounts is a decided benefit to blast furnace operation. Bessemer ore should have less than .001% P for every unit of Fe. In ordinary amounts, P has no effect on blast furnace operation but about 1% in the Fe makes the latter more fluid. High-P irons may be useful in cleaning out the blast furnace hearth. Elimination of P in steel making offers no difficulties. Usually it is cheaper to remove it in basic open-hearth than to eliminate it from the ore. Majority of ores do not have more than 0.10% S present as FeS_2 and FeS. Cheapest place to remove S is in blast furnace and with proper handling S in Fe may be kept as low as desired. Ti is present in ore up to 2-3% as TiO_2 and little of it is reduced in blast furnace. It has been claimed that over 1% TiO_2 in the ore causes infusible compounds to build up in the hearth and furnace men do not care to use ores containing more than this amount. Cu, Cr, V, Ni, Co, Zn, etc. are quite rare in ores. If these elements in the Fe must be controlled closely, it must be done by proper selection of the raw materials. MS (31)

ORE CONCENTRATION (33)

Flotation (33c)

Production of High-Grade Concentrate from Butte Copper Ores—Results of Laboratory Investigations. Bayard S. Morrow & George G. Griswold, Jr. *American Institute of Mining & Metallurgical Engineers, Contribution* No. 27, Feb. 1933, 11 pages. Laboratory studies indicated that a higher-grade concentrate with same recovery could be obtained by a change in the flow sheet. In the present practice a concentrate containing 28% Cu is recovered from a sulphide ore containing 5.5% Cu. The loss in Cu in tailings amounts to 3.76% of the total Cu. Proposed flow sheet discards a comparatively high-Cu tailing from the primary flotation. The concentrate contains 40% Cu. JLG (33c)

Preliminary Concentration Tests on Ores from Chibougaman District, Quebec, for Metallum, Ltd., Montreal. Alex. K. Anderson. *Canada Department Mines, Mines Branch, Report* No. 728, 1932, pages 44-50. Tests on 7 lots of Cu-Fe pyrite ores in siliceous gangues, showed that flotation gave satisfactory concentration. AHE (33c)

Design, Equipment, and Construction Costs of the Davis-Dunkirk Concentrator, Prescott, Ariz. E. L. Sweeney. *United States Bureau of Mines, Information Circular* No. 6730, June 1933, 5 pages. A 75 ton per day concentrator for making a single Au-Ag-Cu concentrate from Ag-Cu ore by flotation cost $406/ton of daily capacity. It would have cost $449 if all new equipment had been used. AHE (33c)

The Recovery of Gold and Copper from the Ore of the Telluride Gold Mines of Canada, Ltd., Englehart, Ontario. Alex. K. Anderson. *Canada Department Mines, Mines Branch, Report* No. 728, 1932, page 19-26. Chalcopyrite in specular Fe assaying Cu 2.67%, Zn 0.12%, Pb 0.02%, Fe 33.7% and Au 0.33 and Ag 0.28 oz./ton was tested. High recoveries of Cu (98%) and Au (92%) are possible by flotation; the concentrate assayed Cu 15% and Au 1.56 oz. Fine grinding, 85%-200 mesh, gives the best results. Aerofloat keeps most of the Au in the cleaned concentrate. The use of much lime is detrimental; only 1 lb./ton is needed. AHE (33c)

Experimental Tests on Old Cyanide Tailings from the Wright-Hargreaves Mines, Limited, Kirkland Lake, Ontario. J. S. Godard. *Canada Department Mines, Mines Branch, Report* No. 728, 1932, pages 50-60. Tailings from cyanide mill assaying 0.093 oz. of Au/ton were concentrated by flotation using soda ash 3.0, water-gas tar A 0.15, amyl xanthate 0.10 and pine oil 0.10 lb./ton. Concentrate assayed 1.6 oz. Au/ton; recovery was 70%. Only 50% extraction of Au can be obtained by cyanidation of the concentrate. An oxidizing roast followed by cyanidation gave 91% extraction. AHE (33c)

Cost of Equipping and Developing a Small Gold Mine in the Bradshaw Mountains Quadrangle, Yavapai County, Ariz. David C. Minton, Jr. *United States Bureau of Mines, Information Circular* 6735, June 1933, 10 pages. A Au-bearing quartz is concentrated by flotation in a small mill (50 tons/day). The total cost of mill equipment was $7,687. Operating costs were $1.95/ton for 2,370 tons of ore. AHE (33c)

Concentration Tests on Gold Ore from the Howey Gold Mines, Ltd., Red Lake, Ontario. C. S. Parsons. *Canada Department Mines, Mines Branch, Report* No. 728, 1932, pages 5-9. An ore containing Au 0.32 oz. and Ag 0.12 oz./ton was tested by tabling and flotation. Classification and tabling of the coarse product gave a concentrate assaying Au 1.22 oz. and containing 91.5% of the values and a tailing assaying Au 0.06 oz. Flotation gave a higher grade concentrate but poorer recoveries. To apply flotation successfully the ore must be ground to —65 mesh. AHE (33c)

Froth Flotation of Auriferous Pyrites. Tests at Golden Point Mine, MacRae's Flat, Otago, New Zealand. George Holcombe. *Mining Journal,* Vol. 180, Mar. 11, 1933, pages 155-156. A quartz ore in graphite schist is stamped and amalgamated. Losses of fine mineral are high, often as much as 40%. Data on flotation tests of slimes with 21 combinations of $CuSO_4$, 5 xanthates (Na, K, amyl, butyl and pentasol), mineral oil, Stockholm tar, coal tar, pine oil, cresylic acid, kerosene and castor oil are given tabularly and show that flotation gives results superior to those from mechanical concentration. AHE (33c)

Pyrite Flotation at Aldermac, Quebec. W. G. Hubler. *Transactions Canadian Institute of Mining & Metallurgy,* 1932, pages 82-91. See *Metals & Alloys,* Vol. 3, July 1932, page MA 231. AHE (33c)

Concentration of an Iron Sulphide Ore, Algoma District, Ontario. C. S. Parsons. *Canada Department Mines, Mines Branch, Report* No. 728, 1932, pages 32-35. A pyrite-pyrrhotite ore analyzing Fe 43.8 and S 36.0% can be concentrated by flotation to give a product containing Fe 47.00% and S 50.39% suitable for use in a Freeman pyrite burner. Recovery was 85.7%. AHE (33c)

Concentration of A Molybdenite Ore from Alice Arm, British Columbia. C. S. Parsons. *Canada Department Mines, Mines Branch, Report* No. 728, 1932, pages 26-31. The ore analyzed MoS_2 1.67, Fe 2.41 and insoluble 83.00%. A preliminary flotation gives a concentrate assaying 50% MoS_2. Regrinding to 80% —200 mesh, and refloating gives an 80% concentration at a 90% recovery. A flow sheet is recommended. AHE (33c)

Enriching Beryllium Ores Mechanically. (Contributo allo studio dell' arricchimento meccanico delle rocce a berillo.) *Giornale di Chimica Industriale ed Applicata,* Vol. 15, Jan. 1933, pages 13-15. Beryl can be separated from quartz by flotation using Na oleate, $Ba(NO_3)_2$ and pine oil, in the proportion 100-150-50 g./ton of mineral. Separation of beryl from feldspar is being investigated, good separation having been obtained using Ferraris type rifflers. AWC (33c)

Magnetic Separation (33d)

Preliminary Investigations on Magnetization of Hematite Quartzites. N. N. Pavlov & Vasiletz. *Domez,* No. 12, 1932, pages 61-66 (In Russian). Large deposits of low grade Fe ore in or around Krivoi Rog consist of quartz with hematite or magnetite, 30 to 40% of the ore body being a magnetite formation containing 25-35% Fe and the rest hematitic with 30 to 55% Fe. Conversion of Fe_2O_3 into magnetic Fe_3O_4 involves accurate control of temperature and time of reaction. Heating to 690°-720° C., preferably near the lower figure, gave magnetic properties without any changes in composition. Fast heating to this temperature (5 to 8 minutes) and moderately slow cooling (10-15 minutes) is preferable. Holding at the temperature longer than 2 minutes gave lowered results. Application of a magnetic field during heating or cooling of the specimens did not influence the final properties. (33d)

Crushing (33e)

Gravity Stamp Mills. T. W. Wardell. *Crushing & Grinding,* Vol. 1, July-Aug. 1932, pages 186-187. Nissen mill is described. AHE (33e)

A Revolutionary Mill? *Canadian Mining & Metallurgical Bulletin* No. 247, Nov. 1932, pages 597-601. Hadsell mill is described and illustrated. Results of 3 tests are given. Mill is only device that can reduce run-of-mine ore economically to a finished product in 1 operation. Lumps as large as 2 ft. have been ground to 95% through 200 mesh with ½ power required by crushers, ball mills and classifiers. Operation is simple; overloading is difficult; repairs are very low. AHE (33e)

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MANUFACTURERS' LITERATURE

Lubricants

To reduce oil consumption and keep bearings cooler E. F. Houghton & Company recommend the use of their "Sta-Put" lubricants. A folder being distributed by the company describes their three oil series, ranging from light machine oils to greases for automatic pressure lubricating systems. (1)

Insulating Brick

Armstrong's insulating brick will withstand 2500° F. without shrinking, calcining or spalling and will withstand over 200 lbs./in.^{2} under compression according to a booklet received from the Armstrong Cork & Insulation Company. The brick are made in all standard refractory shapes, and special shapes can be made to specification. A table shows the conductivity of Armstrong's brick compared with that of standard fire brick. (2)

Hardening

Bulletin No. L-960 from Leeds & Northrup Company shows how substantial savings are effected in tool and die costs by the addition of the recently developed Vapocarb atmospheric control to the well-known Hump Method for hardening. One page of the bulletin lists applications of L&N measuring and controlling equipment and electric heat treating furnaces for the metal working industries. (3)

Arc Welding Copper

Arc Welding Copper to Copper and Copper to Steel is the subject of a 12-page booklet, Bulletin No. D-7, just released by The Hobart Brothers Company. It contains detailed instructions for applying their newly developed "Long Arc" method, which is said to be the first practical method of arc welding either electrolytic or deoxidized copper with strength equal to that of annealed copper. (4)

Oil Hardening Tool Steel

A folder from the Detroit Alloy Steel Company announces their "Carbomang," an oil-hardening tool steel, cast to shape. It has an extremely wide range of application, being suitable for tools and dies not requiring the finest grades of alloy steels, and its economy permits it to be used at a saving in all cases. (5)

Welding Aluminum

The Aluminum Company of America has prepared a revised version of their booklet "The Welding of Aluminum." It contains specific instructions for the welding of aluminum and its alloys with a brief discussion of the principles involved. It is intended for the practical welder and no academic discussion of the problem has been attempted. (6)

Case Hardening Steel

The Aerocase process for case hardening steel in a liquid bath is the result of several years work in the laboratories of the American Cyanamid & Chemical Corporation. The principal features of the process are described in detail in a booklet sent out by the company and a leaflet gives a case in practice where quality was improved and economy effected by the use of this process for heat treating medium carbon alloy steel. (7)

Electric Air Heaters

Bulletin CA-108 from Edwin L. Wiegand Company describes their Chromalox electric air heaters for shops and other hard-to-heat places. Bulletin CA-106 discusses their immersion heaters for heating tanks, fluids in containers, etc. (8)

Liquid Level Gages

The Foxboro Company has prepared their Bulletin 187 which contains a complete description of the industrial and commercial uses and the mechanical construction of their liquid level gages. These instruments are for the measurement of the level of liquids open to the atmosphere. For the measurement of levels in closed tanks the company will furnish information on the differential type liquid level gage. (9)

Wrought Iron

An interesting booklet from the A. M. Byers Company entitled "The New Story of Ancient Wrought Iron" illustrates each step in the process of making wrought iron by the new Byers method as compared with the older hand-puddling method. (10)

X-Ray Inspection

Bulletin No. 200 from The Electro Alloys Company describes their X-ray inspection service of Thermalloy heat-resisting castings for high temperature work. Considerable data on their use of X-ray tubes and "Radon" capsules to check foundry practice are presented. Typical radiographs and alloy physical properties are included. (11)

Acid-Resisting Alloy

The Duriron Company, Inc., has announced their Durichlor, a new acid-resisting alloy which is almost entirely resistant to hydrochloric acid at all concentrations and at all temperatures up to the boiling point. It fills the need for an alloy with satisfactory chemical resistance, good heat transfer properties and good physical characteristics. A leaflet showing its properties is available. (12)

Pyrometers

Catalog Part 4000 from the Taylor Instrument Companies tells the complete story of pyrometers. In addition to illustrating the various types and accessories which can be furnished, pyrometric terms are defined, the working of the numerous parts of the instrument is explained and several pages are devoted to thermocouple installation methods. (13)

Steel Products

The Youngstown Sheet & Tube Company has compiled a booklet listing the various products made by them. Catalogues giving more complete information on any of the items may be obtained from the company. (14)

Stiffness Tester

Bulletin E-10133 from the Smith-Taber Company is a technical description of their stiffness tester for testing papers, aluminum wire and sheet, brass and bronze sheet, textiles, metal foil, etc. It gives an accurate numerical determination of pliability. The operation of the instrument is explained in detail. (15)

Bronze Castings

Bulletin B-1 from The Superheater Company, Bronze Foundry Division, describes their bronze castings, rough or finished, in three classes of mixtures, namely, standard bronzes, aluminum bronzes and super-tensile manganese bronze, the latter under its trade name "Elesco." (16)

Heat Treating Furnaces

A recent bulletin from the Surface Combustion Corporation is devoted to their gas fired heat treating furnaces giving illustrations of various actual installations. The bulletin emphasizes the fact that these furnaces are equipped with self-cooling burners and automatic proportioning firing equipment. (17)

Corrosion and Heat Resistant Alloys

A recent folder from the General Alloys Company gives a general description of five Q-Alloys, including the particular applications for which each is suitable, and data on their physical properties. (18)

Plastic Refractory Materials

The Chas. Taylor Sons Company discuss their P. B. Sillimanite ramming mixture in a recent booklet. Shrinkage has been reduced to a minimum in this refractory and the mechanical strength developed in firing is ample for all types of furnace construction. The method of installing it is given. (19)

Monel Metal

The International Nickel Company has prepared a copy of the revised Federal Specifications on Monel Metal issued by the government. It is to be inserted in their handbook entitled "Monel Metal and Rolled Nickel—Technical Data." (20)

Thermometers and Pressure Gages

Catalog 6702 from the Brown Instrument Company features their new line of thermometers and pressure gages. They are available in indicating, recording and controlling types and have many new and improved features. They are operated by mercury-in-glass switches thus eliminating relays and exposed contacts. (21)

Stainless Steel

An attractive booklet from the American Sheet & Tin Plate Company discusses their stainless and heat resisting steels. As an aid in selecting the proper type for a given purpose the characteristics of each are listed. The fabrication of each type is discussed separately and in great detail. (22)

Welding Wire

A leaflet from the American Steel & Wire Company urges the use of their Premier welding wire for welds of maximum strength. Each bundle of this wire is tested for uniformity, perfect fusion, impurities and general efficiency before it is placed on the market. (23)

Binocular Microscope

Bulletin No. 9 from E. Leitz, Inc. illustrates a number of new constructions in wide field instruments with special reference to an automatic multiple objective nosepiece. (24)

Hoists

Details of construction of the Milwaukee electric hoists with single and variable speed control are given in a pamphlet sent out by the Harnischfeger Corporation. The company is prepared to furnish hoists to answer every material handling need. (25)

Portable Tensile Testing Machine

A 15-page booklet from the Linde Air Products Company gives details of construction and complete directions for operating their portable tensile testing machine. It also contains an explanation of the proper methods of preparing samples for testing. Calculations of the ultimate tensile strength are simplified by a chart of the alignment or nomographictype. (26)

Getting Results from Babbitt Metal

A booklet from the Merchant & Evans Company emphasizes the fact that cleanliness is the most important feature in pouring Babbitt metal. Full directions are given, followed by a description of four of the brands of Babbitt metal manufactured by them. (27)

Aluminum Paint

An attractive booklet from the Aluminum Company of America illustrates the application of aluminum paint in many industries, including railroads, aviation, marine industry, laundries, textiles, garages, foundry patterns, and others. (28)

Stainless Steels

The American Rolling Mill Company has prepared a most useful handbook on their Armco 18-8 and Armco 17 stainless steel alloys. In addition to good corrosion resistance these alloys are characterized by good ductility, and they lend themselves well to such fabricating operations as punching and shearing, welding, spinning and soldering. The handbook tells how they may be fabricated most economically. (29)

"Spots of Heat"

An attractive little booklet from the General Electric Company shows by means of a miniature movie the uses for their spot, strip and dip electric heating units in industrial plants. (30)

Magnesium Alloys

The Dow Chemical Company has prepared a booklet containing general information concerning their Dowmetal, a series of magnesium-base alloys developed and manufactured by them. These alloys are the lightest of all engineering metals commercially available, they may be machined easily, they may be welded with an oxyacetylene torch and riveting presents no difficulties. (31)

Refractory Cements

A folder recently received from Johns-Manville gives in tabular form the useful characteristics of their refractory cements. A particularly convenient table gives the J-M refractory cement recommendations as applied in various industries, such as the oil, gas, and steel industries, lime and cement kilns, non-ferrous metals industry, etc. (32)

Tantalum

The Fansteel Products Company, Inc., has prepared a booklet relating to the uses of tantalum as a corrosion resistant. This remarkable element is proof against almost every kind of corrosive reagent, is available in all commercial forms and is variable in hardness from a lead-like softness to a steely toughness. (33)

Electric Heating Elements

Bulletin B from the Globar Corporation is devoted to their electric heating elements and terminal accessories for industrial applications. A list of their stock elements is given and several methods of mounting the elements in industrial furnaces are illustrated. (34)

Furnace Bottom Refractory

The Quigley Company, Inc., has issued a leaflet describing their "Hearth-Crete," a chrome-base castable refractory, giving its uses, such as building monolithic bottoms in forging, bar, plate, angle, rolling mill, and other steel heating furnaces. Its ten points of superiority are cited. (35)

Stainless Clad Steel

The Ingersoll Steel & Disc Company has sent out a leaflet which illustrates the various uses of their "IngOclad," a mild carbon steel clad with stainless. These range from huge 150 barrel capacity beer tanks to automobile wheels and cooking utensils. (36)

Alloy Steel Castings

A booklet from the Lebanon Steel Foundry discusses both their alloy steel castings for high stresses and wear resistance, for structural purposes requiring higher physical values than those of plain carbon steel castings, and their stainless alloy steel castings for heat resistance and corrosion resistance at normal and elevated temperatures. (37)

Phosphor Bronze and Nickel Silver

A complete range of free-cutting phosphor bronze, nickel silver and special bronze alloys have been developed for high speed, automatic milling, threading and machining by the Riverside Metal Company. A folder from them gives the outstanding characteristics of these metals together with many suggested applications. (38)

Seamless Drawn Fittings

Bulletin 51-1 from Tube-Turns, Inc., contains descriptive information and dimensional data on their complete line of thin gauge copper tube-turns, elbows and return (180°) type fittings for use in distillery and brewery process lines. (39)

Cutting Oils

Much interesting information will be found in the third edition of the catalog from D. A. Stuart & Company. Various helpful articles and comments on lubrication and cutting oil problems are alternated with the advertisements of the Stuart products. (40)

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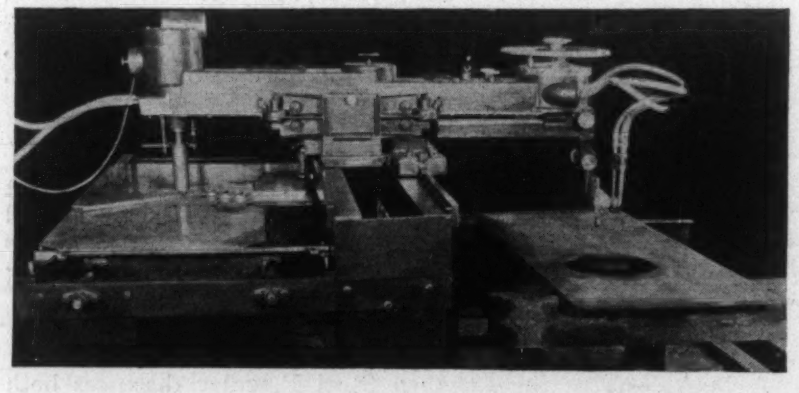
NEW MATERIALS and EQUIPMENT

Oxweld Pantosec

The Linde Air Products Company, New York, has introduced a new stationary cutting machine known as the Pantosec. Being a precision shape-cutting instrument, it is especially suitable for cutting dies, cams, and other parts that must be smoothly and accurately cut. With a cutting range of 44-in. longitudinally and 20-in. laterally, it does straight-line cutting, angle cutting, beveling, circle-cutting and intricate shape-cutting. It requires a floor space of only 72 x 83 in. The Pantosec can be operated with a minimum of attention from either the templet end or the blowpipe end, as a hand-guided or as a machine-guided instrument. Angles can be cut without templets, since the cutting head can be locked for travel in any direction. Bevel-cutting is simplified; the provisions for adjusting the machine to the work make it possible to line up the blow-pipe without shifting the work; and the dividing head enables the operator to set stops on work that is to be cut in several directions. An extension so mounted as to be always steady and secure, makes it unnecessary for the operator to return to the back to start the profile cutting after the entry cut has been made. The machine consists of a carriage mounted on three-point supports. The piping for the gases is all enclosed in the carriage, and all drives are protected by dirt-proof casings.

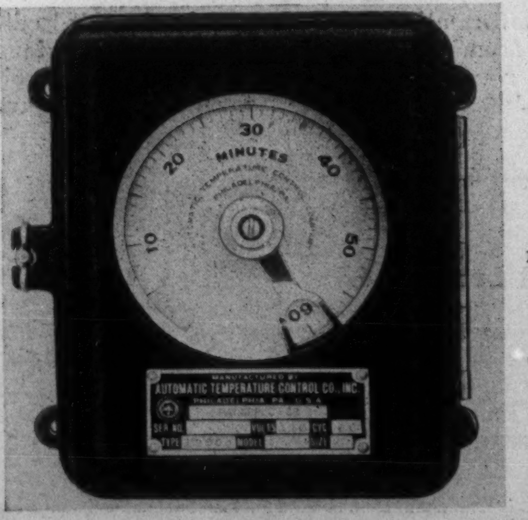


Small Lectromelt Furnace

The Pittsburgh Lectromelt Furnace Corp., Pittsburgh, Pa., has developed a 25-pound Lectromelt furnace. This small size arc furnace operates with either direct, indirect or submerged arcs. The furnace body may be conveniently removed from its stand and the melt poured off as from a shank ladle. The roof and electrode arms are arranged for tilting back by means of a lever mechanism so as to facilitate quick and convenient charging. The furnace may also be "tapped" when that is desired. The 25-pound Lectromelt furnace is usually operated direct on 110 volts A.C. or with a transformer on 220, 440 or even higher voltage power supplies. The furnace has an extremely wide range of usability such as melting, refining and alloying irons and steels, melting ferro alloys and non-ferrous metals and alloys, for fusion investigations and ore reductions, etc.

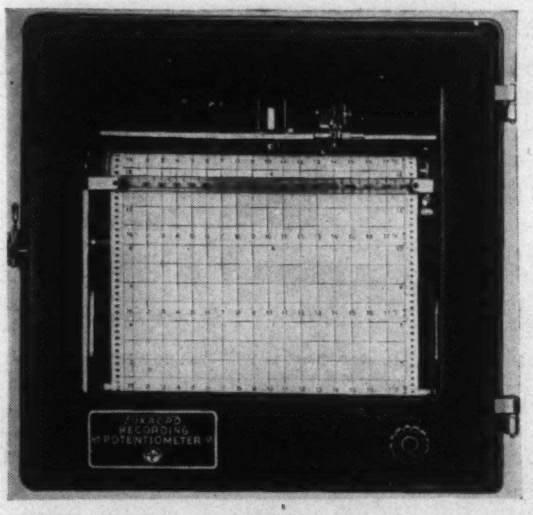
Adjustable-Timing Contactor

A new design of timing contactor for plant operation has been added to the line of the Automatic Temperature Control Co., Philadelphia, Pa. This Type 1290 is sturdy, has a minimum number of parts, will operate in any position without the need of leveling and is unaffected by vibration, yet the elapsed time can be set to a split scale division for any range desired within the dial selected. Power is obtained from a reversing synchronous motor and the contact arm moves alternately clockwise and counterclockwise within the time limit set, making a 10-amp. 110-volt a.c. load circuit for an adjustable time at either extreme of its travel. Timing contactors of this new tester are also available to be actuated from a momentary contact switch, run for the time cycle for which they have been adjusted and stop until the starting switch is again energized. These "cycle stop" type contactors make and hold their load circuit at the expiration of the time set, or they may be supplied to make the load circuit at start of the time cycle and break it when the time set has elapsed.



New Recording Pyrometer

A new and unique type of balancing mechanism is one of the important features of the new recording potentiometer pyrometer designed and manufactured by the Foxboro Company, Foxboro, Mass. It is so designed that it produces a large movement of the pen or print wheel for a small galvanometer deflection. It is claimed that this results in rapid frequency of records, long wearing mechanism, and open, easily-read chart scale. The balancing mechanism consists essentially of a V-shaped drive cam and a friction roller. The sensing fingers, which detect galvanometer deflection, position the friction roller according to the position of the galvanometer pointer. The V-shaped drive cam then engages and rotates the roller, which in turn transmits its straight-line motion to the slide-wire contact, moving it a corresponding distance. The pen or print wheel, being mounted integrally with the slide-wire contact, moves with it, thus making the record coincide accurately with the measurement. The recorder is housed in a new fume-tight and dust-proof case with large glass window which makes the chart and interior of the instrument highly visible. The entire mechanism can be swung forward out of the case, making every part accessible for inspection. The drive motor mounted in rubber bushings which silence it and prevent transmission of vibration to the instrument, is completely enclosed, runs in ball bearings, has a centrifugal starting switch, and has no brushes. The printing mechanism is mounted on the top front of the multiple record pyrometer. Each record is identified by a color. The printing styles of the rotating print wheel are inked by colored-ink rollers and print the record on the upper surface of the chart paper. The record dots are square in shape, a distinguishing feature of the Foxboro Recorder, and large enough for the colors to be easily recognized. The ink dries before the record has moved more than a few inches.

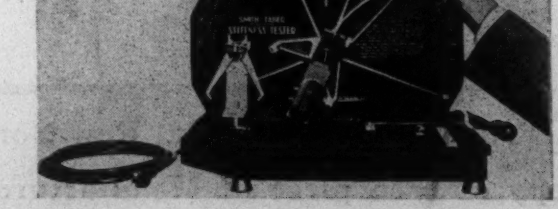


Just below the upper chart roller, the chart passes under a scale plate of transparent, unbreakable material with the scale graduations engraved on it. This identifies the temperature values of the chart lines, and since it is transparent, the record can be observed through it.

The connection compartment sealed from the interior of the case and accessible from the outside, allows thermocouple and motor connections to be made or inspected without opening the main compartment containing the mechanism.

Stiffness and Resiliency Tester

Various tests which heretofore have been either impracticable or inconclusive are said to be made possible by means of this new design developed by Smith-Taber, North Tonawanda, N. Y. The principles involved in the proposed quantitative determinations are simple; the apparatus is designed and constructed to minimize the personal equation. Among other features are built-in means for shearing light materials into uniform specimens, signal lights for end point, etc.



New Model Optical Pyrometer

The Pyrometer Instrument Co., New York, N. Y., now announce a new model Pyro optical pyrometer, which has 3 separate scales incorporated in one and the same instrument. A low range scale (1400° to 2200° F.) for black body conditions, a high range scale (1800° to 3400° F.) also for black body conditions and a third scale range (2200° to 3600° F.) claimed to be corrected for reading molten iron and steel in the open.